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SOURCE ASSESSMENT:
PRIORITIZATION OF AIR POLLUTION FROM INDUSTRIAL SURFACE COATING OPERATIONS

MONSANTO RESEARCH CORPORATION

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SOURCE ASSESSMENT:
PRIORITIZATION OF AIR POLLUTION FROM INDUSTRIAL SURFACE COATING OPERATIONS

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PRIORITIZATION OF AIR POLLUTION FROM INDUSTRIAL SURFACE COATING OPERATIONS

by
T.W. Hughes, D.A. Horn, C.W. Sandy, and R.W. Serth
Monsanto Research Corporation
Dayton Laboratory
Dayton, Ohio 45407

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EPA Task Officer: Dale A. Denny
Control Systems Laboratory
National Environmental Research Center
Research Triangle Park, North Carolina 27711

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February 1975

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The report summarizes the results of a program to gather and analyze background information and technical data to establish a data base for the purpose of prioritizing atmospheric emissions from industrial surface coating operations, excluding automobile and architectural painting. The report contains a prioritized listing of industrial sources of air pollution for each of ten product-type categories. Additionally, surface coating processes are discussed, together with applicable emission control technology.

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PREFACE

The report summarizes the results of a program to gather and analyze background information and technical data to establish a data base for the purpose of prioritizing atmospheric emissions from industrial surface coating operations, excluding automobile and architectural painting. The report contains a prioritized listing of industrial sources of air pollution for each of ten product-type categories. Additionally, surface coating processes are discussed, together with applicable emission control technology.

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SECTION I

INTRODUCTION

Industrial surface coating operations, excluding those associated with automobile and architectural painting, are utilized in the coating of sheet, strip, coil, paper and paperboard, in treating fabrics, and in finishing appliances, machinery and furniture. These coating operations produce hydrocarbon emissions, primarily solvents and resins, and particulate emissions.

Background information and technical data were collected and analyzed in this study in order to establish a data base for prioritizing atmospheric emissions from industrial surface coating operations, excluding automobile and architectural painting. This special project was undertaken to provide information on solvent evaporation processes required by the EPA for use in establishing New Source Performance Standards for industrial surface coating operations.

Information and data were scrutinized and reduced to a form suitable for the development of a prioritization listing. The reader should be mindful, however, that qualitative judgements and engineering estimates were made where data were lacking. Priority lists were generated to: (1) assess the related health hazards created by the emitted species, by photochemical oxidants formed from emitted species, and by both of the preceding materials on a worst case basis, and (2) assess the relative mass of emissions associated with the surface coatings considered. These priority lists identify the major industrial surface coating emission points by product type.

This Final Report thus contains a prioritized listing of industrial sources of air pollutants for each of 10 product-type categories: major appliance finishing, small appliance finishing, farm machinery finishing, industrial machinery finishing, commercial machinery finishing, wood furniture finishing, sheet, strip, and coil coating, metal furniture finishing, paper and paperboard coating, and fabric treatment.

This special prioritization listing and report are part of a Source Assessment program involving the assessment of a large number of sources of air emissions in order to determine their impact on the environment and to provide comprehensive information to the EPA for use in deciding on the need for the development of additional pollution control technology.

SECTION II

SUMMARY

Industrial surface coating operations are a source of hydrocarbon emissions. These emissions total 1.3 x 10^9 kg/year for the following: major appliance finishing, small appliance finishing, farm machinery finishing, industrial machinery finishing, commercial machinery finishing, wood furniture finishing, sheet, strip, and coil coating, metal furniture finishing, paper and paperboard coating, and fabric treatment. Emission rates from each of these industries are summarized below.

Source	Hydrocarbon emission rate,[a] 10^6 kg/year
Automobile and truck finishing[b]	100
Major appliance finishing	30
Small appliance finishing	3
Farm machinery finishing	2
Industrial machinery finishing	8
Commercial machinery finishing	1
Wood furniture finishing	9
Sheet, strip, and coil coating	500
Metal furniture finishing	8
Paper and paperboard coating	500
Fabric treatment	200

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[a] Numbers rounded to one significant number.
[b] Not considered in this program.

The emission sources considered in this program are depicted graphically below.

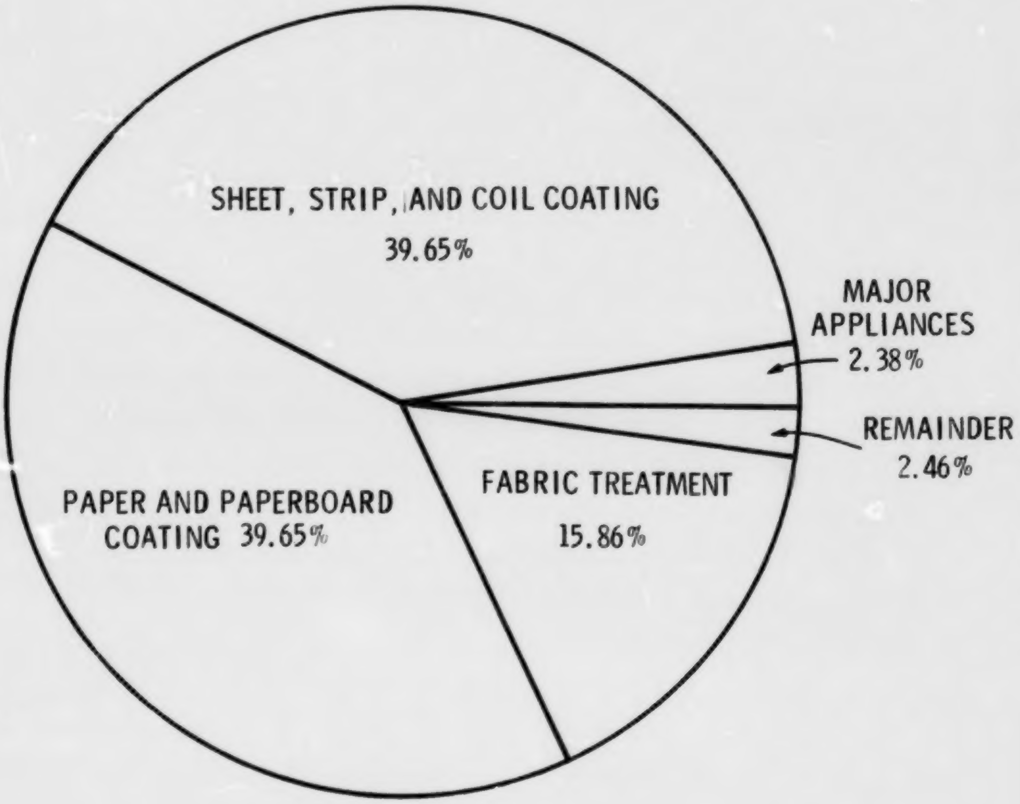

Figure 1. Summary of emission rates from industrial surface coating operations

Together, sheet, strip, and coil coating, paper and paperboard coating, and fabric treatment account for 95% of all emissions considered in this program. Detailed lists of emissions from each of these three categories are presented below.

Emissions from sheet, strip, and coil coating

Source	Hydrocarbon emission rate, kg/year
Metal cans - excluding beverage cans	200,000,000
Beverage cans	200,000,000
Ductwork	40,000,000
Wood paneling	10,000,000
Canopies and awnings	10,000,000
Screening	5,000,000
Fencing	4,000,000
Metal doors - excluding garage doors	2,000,000
Gutters	2,000,000
Aluminum siding and roofing	2,000,000
Beer and soft drink bottle caps	1,000,000
Garage doors	1,000,000
Door and window frames	600,000
Railings, fire escapes, staircases	300,000
Shelving	40,000
Steel shipping barrels	20,000
Wire products	20,000

Emissions from paper and paperboard coating

Source	Hydrocarbon emission rate, kg/year
Paper bags	200,000,000
Kraft paper	70,000,000
Coated paper - excluding waxed	70,000,000
Printing paper	50,000,000
Oil and waxed paper	40,000,000
Milk carton board	20,000,000
Paper boxes	20,000,000
Folding cartons	5,000,000
Paper cans, tubes, drums	2,000,000

Emissions from fabric treatment

Source	Hydrocarbon emission rate, kg/year
Dyeing	200,000,000
Sizing	10,000,000
Wrinkle resistant finishes	800,000
Permanent crispness	200,000
Waterproof and water repellant finishes	9,000

Emissions originate from more than 8,700 plants which have total sales of more than $500,000 per plant per year. A total of 85% of these plants are located in the following 19 states: Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York, Massachusetts, Connecticut, California, Oregon, Washington, Tennessee, North Carolina, Texas, and New Jersey.

Methods of controlling these emissions include adsorption, absorption, incineration, solvent reformulation, conversion to solventless coatings, and vapor condensation.

The hydrocarbon species emitted from industrial surface coating operations include solvents and resins. The solvent species include alcohols, esters, glycol ethers, ketones, hydrocarbons, halogenated hydrocarbons, and nitroparaffins. These are listed below.

SOLVENT SPECIES IN EMITTED HYDROCARBONS

Alcohols

- Methyl alcohol
- Ethyl alcohol
- Isopropyl alcohol
- n-Propyl alcohol
- n-Butyl alcohol
- sec-Butyl alcohol
- Isobutyl alcohol
- Methyl isobutyl carbinol

Esters

- Ethyl acetate
- Isopropyl acetate
- n-Butyl acetate
- sec-Butyl acetate
- Amyl acetate
- Methyl amyl acetate
- Ethylene glycol monoethyl ether acetate
- Ethylene glycol monobutyl ether acetate

Glycol ethers

- Ethylene glycol monomethyl ether
- Ethylene glycol monoethyl ether
- Ethylene glycol monobutyl ether
- Diethylene glycol monoethyl ether
- Diethylene glycol monomethyl ether
- Diethylene glycol monobutyl ether

Ketones

- Acetone
- Methyl ethyl ketone
- Methyl isobutyl ketone
- Methyl isoamyl ketone
- Diisobutyl ketone
- Cyclohexanone
- Diacetone alcohol
- Isophorone

Hydrocarbons

- Aliphatic:
  - Hexane
  - Heptane
  - VM&P naphtha (typical)
  - Mineral spirits (typical)
- Aromatic:
  - Benzene
  - Toluene
  - Xylene (mixed)
  - High flash aromatic naphtha (typical)

Halogenated hydrocarbons

- Carbon tetrachloride
- Trichloroethylene
- Perchloroethylene

Nitroparaffins

- Nitroethane
- Nitropropane
- sec-Nitropropane

The resin species include the monomers of the following: acrylic resins, alkyd resins, cellulose acetate resins, epoxy resins, polystyrene resins, vinyl chloride-acetate resins, vinyl acetate resins, etc.

The particulates emitted from industrial surface coating operations include kaolin, magnesium chloride, surfactants, diethanolamine salts, resin powders, dyes, etc.

SECTION III

SOURCE DESCRIPTION

A. GENERAL SURFACE COATING INDUSTRY

The ASTM definition of a surface coating is "a liquid, liquefiable, or mastic composition which is converted to a solid protective, decorative, or functional adherent film after application as a thin layer."[1] These coatings are applied to wood, metal, paper, fabric, glass, stone, concrete, plastic, and other types of surfaces. The types of surface coatings which are used include paints, varnishes, lacquers, stains, shellacs, polymer films, waxes, oils, and others.[1]

Surface coatings which are produced by the surface coating industry are sold through both trade and industrial sales.[2] Trade sales include interior and exterior, solvent and water-base paints, automotive refinishing lacquers, traffic paints, and others. Industrial sales consist of industrial product and maintenance finishes, paper and paperboard coating, and fabric treatment.

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[1] Standard Definition of Terms Relating to Paint, Varnish, Lacquer, and Related Products, A.S.T.M. Designation D 16-68. Reprinted by permission of the A.S.T.M. from copyrighted material.

[2] Preliminary Report, 1972 Census of Manufactures, Paints and Allied Products, Standard Industrial Classification 2851, U.S. Department of Commerce, MC 72(P)-28E, March, 1974.

The surface coating industry for paints and allied products is presented in Figure 2. This figure shows the shipments and values of these shipments for 1972 based upon data supplied in the 1972 Census of Manufactures.[2] The data in Figure 2 represent 93 percent of the total manufactured product shipments and 98 percent of the total product value of all shipments.[2]

B. SURFACE COATINGS

1. Compositions

Surface coatings consume a greater number and variety of chemicals and chemical intermediates than any other segment of the chemical industry.[3] Tables 1, 2, and 3 present typical lists of the various chemical raw materials used in surface coatings. In 1972, surface coatings consumed 7.77 billion kilograms of raw materials at an estimated value of 1.94 billion dollars.

Surface coatings consist of four basic components: film formers, pigments, solvents, and additives. These components are discussed below.

a. Film Formers - film formers consist of synthetic resins (alkyd, vinyl, acrylic, epoxy, urethane, cellulosic, etc.), drying oils (linseed oil, tall oil, tung oil, castor oil, etc.), and natural resins (rosin, shellac, etc.). These materials form the protective film of the surface coating and, hence, they are the backbone of the protective coating.[3]

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[3] Chemical Economics Handbook, Stanford Research Institute, December, 1971.

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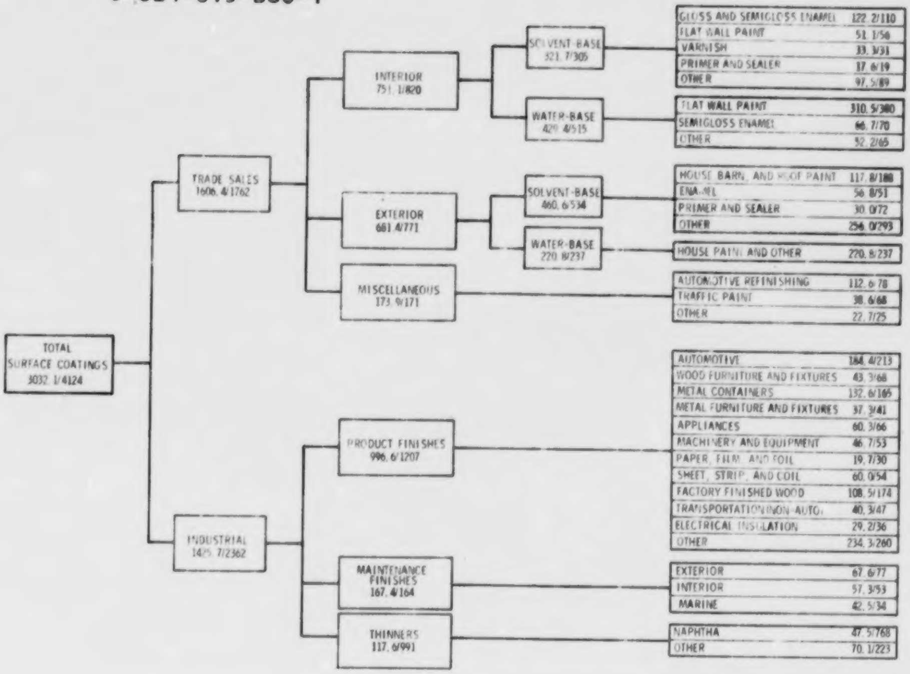
TOTAL SURFACE COATINGS 3032.1/4124
TRADE SALES 1606.4/1762
INTERIOR 751.1/820
SOLVENT-BASE 321.7/305
GLOSS AND SEMIGLOSS ENAMEL 122.2/110
FLAT WALL PAINT 51.1/56
VARNISH 33.3/31
PRIMER AND SEALER 17.6/19
OTHER 97.5/89
WATER-BASE 429.4/515
FLAT WALL PAINT 310.5/380
SEMIGLOSS ENAMEL 66.7/70
OTHER 52.2/65
EXTERIOR 681.4/771
SOLVENT-BASE 460.6/534
HOUSE BARN, AND ROOF PAINT 117.8/188
ENAMEL 56.8/51
PRIMER AND SEALER 30.0/72
OTHER 256.0/293
WATER-BASE 220.8/237
HOUSE PAINT AND OTHER 220.8/237
MISCELLANEOUS 173.9/171
AUTOMOTIVE REFINISHING 112.6/78
TRAFFIC PAINT 38.6/68
OTHER 22.7/25
INDUSTRIAL 1425.7/2362
PRODUCT FINISHES 996.6/1207
AUTOMOTIVE 184.4/213
WOOD FURNITURE AND FIXTURES 43.3/68
METAL CONTAINERS 132.6/165
METAL FURNITURE AND FIXTURES 37.3/41
APPLIANCES 60.3/66
MACHINERY AND EQUIPMENT 46.7/53
PAPER, FILM, AND FOIL 19.7/30
SHEET, STRIP, AND COIL 60.0/54
FACTORY FINISHED WOOD 108.5/174
TRANSPORTATION(NON-AUTO) 40.3/47
ELECTRICAL INSULATION 29.2/36
OTHER 234.3/260
MAINTENANCE FINISHES 167.4/164
EXTERIOR 67.6/77
INTERIOR 57.3/53
MARINE 42.5/34
THINNERS 117.6/991
NAPHTHA 47.5/768
OTHER 70.1/223

Figure 2. Paints and allied products

Table 1. TYPICAL RAW MATERIALS USED IN THE PAINT AND ALLIED PRODUCTS INDUSTRY

Film formers

- Alkyd resins
- Vinyl resins
- Acrylic resins
- Epoxy resins
- Urethane resins
- Cellulosic resins
- Amino resins
- Rosin esters
- Styrene resins
- Phenolic resins
- Hydrocarbon resins

Pigments

- Titanium dioxide
- Zinc oxide
- White lead
- Calcium carbonate
- Talc
- Calcium sulfate
- Silica
- Barite
- Clay
- Mica
- Chrome pigments
- Red lead and litharge
- Carbon black
- Metallic pigments
- Zinc dust
- Phthalocyanine
- Azo pigments
- Non-azo pigments

Solvents

- Mineral spirits
- Kerosene
- Benzene
- Toluene
- Xylenes
- Naphtha
- Pine oil
- Turpentine
- Methanol
- Ethanol
- Iso-propanol
- n-Propanol
- n-Butyl alcohol
- Glycols
- Glycol ethers
- Acetone
- Methyl ethyl ketone
- Methyl iso-butyl ketone
- Ethyl acetate
- Isopropyl acetate
- n-Butyl acetate
- Methylene chloride
- Trichloroethylene

Additives

- Surfactants
- Paint driers
- Thickeners
- Flow modifiers
- Anti-skinning agents
- Fungicides

Table 2. TYPICAL RAW MATERIALS USED IN THE PAPER AND PAPERBOARD COATING INDUSTRY

Glues and adhesives
Vinyl resins
Urethane resins
Polyethylene resins
Polypropylene resins
Styrenes
Cellulosic resins
Printing ink
Petroleum wax

Table 3. TYPICAL RAW MATERIALS USED IN THE FABRIC TREATMENT INDUSTRY

A. Mechanical processing (lubricants)
- Natural
  - Mineral oils
  - Castor oil
  - Neatsfoot oil
  - Olive oil
  - Peanut oil
  - Sperm oil
  - Sunflower oil
- Synthetic
  - Polyethylene/propylene oxide copolymer

B. Scouring and drycleaning
- Scouring and drycleaning
  - Carbon tetrachloride
  - Hydrocarbon solvents
  - Perchloroethylene
  - Trichloroethylene
  - Petroleum solvents
  - "Shell Clean"
  - White spirit
  - 1,1-Dichloroethylene
  - Alkylarylsulfonate
- Desizing
  - Bacterial amylase
  - "Ensize"
  - Malt extract
  - Pancreatic amylase

C. Finishing
- Stiffening/sizing agents
  - Cellulose derivatives:
    - Alkali-soluble cellulose solutions
    - Carboxy-methyl cellulose
    - Dispersible cellulosic ethers
    - Hydroxyethyl cellulose
  - Gum and gelatins
  - Starches (corn, potato, wheat, etc.)
  - Thermoplastic resins:
    - Polyacrylate
    - Polymethacrylate
    - Polystyrenes
    - Polyvinyl acetate
    - Polyvinyl alcohol
    - Styrene-maleic acid copolymer
  - Thermosetting resins:
    - Dimethylol urea
    - Melamine-formaldehyde resin
    - Monomethyldimethylol urea
    - Urea-formaldehyde resin
    - Talla-base wax
- Textile coating materials
  - Formaldehyde resins
  - Polyvinyl chloride
  - Vinyl acetate
  - Vinyl and acrylic copolymers
  - Vinyl butyral
  - Vinylidene chloride

Table 3. (Cont.) TYPICAL RAW MATERIALS USED IN THE FABRIC TREATMENT INDUSTRY

C. Finishing (continued)

- Hygroscopic agents
    - Ethylene glycol
    - Glucose
    - Glycerol
    - Urea
- Shrink-resistant agents
    - Cyclic alkyl urea-formaldehyde condensates
    - Glyoxal
    - Hydroxyethyl cellulose-formaldehyde complexes
    - Methylated methylol melamines
    - Tetramethylol acetylene diurea
    - Urea- or melamine-formaldehyde resins
- Anti-slip finishes
    - Colloidal silica dispersions
    - Rosin derivatives + zinc acetate
    - Urea-formaldehyde or melamine-formaldehyde resins
    - Various vinyl and acryl resins
- Antistatic finishes
    - Cationic quarternary ammonium salts
    - Fatty amines and their esters
    - Glycerine
    - Magnesium chloride
    - Modified copolymer
    - Polyalkylene oxide
    - Polyethylene glycol
- Crush/wrinkle-resistant finishes
    - Ammonium and amine salt
    - Borates
    - Cyclic alkyl urea-formaldehyde monomers
    - Dicyanodiamide
    - Dicyanodiamide
    - Dimethylol urea
    - Formaldehyde
    - Melamine-formaldehyde monomers
    - Silicates
    - Stannates
    - Urea
    - Zinc chloride
- Flame-retardant finishes
    - Borax + boric acid
    - Modified synthetic polymer (halogen and/or phosphorus)
    - Tetrakis hydroxymethyl phosphonium chloride
    - Triethanolamine
    - Trimethylol melamine
    - Trisaziridinyl phosphine oxide
- Moth-proofing agents
    - Bis-2-hydroxy-5-chlorophenyl methane
    - Cadmium soaps
    - Copper naphthenates
    - Cuprammonium compounds
    - Dieldrin
    - Halogenated and phenylated phenol
    - Naphthalene, camphor, and paradichlorobenzene
    - Phenyl mercurials
    - Salicylanilide
    - Shelltox fumigant strip
    - Sodium, magnesium, or ammonium fluorosilicates
    - Triphenyl methane
    - Triphenyl phosphines
    - Zinc chloride

Table 3. (Cont.) TYPICAL RAW MATERIALS USED IN THE FABRIC TREATMENT INDUSTRY

- C. Finishing (continued)
  - Soil-resistant finishes
    - Acrylate or methacrylate copolymer
    - Fluoro chemicals
    - Perfluoro octanol + acrylic acid
    - Silicones
  - Water-repellent finishes
    - Fluorine containing water and oil repellents
    - Modified melamine-formaldehyde urea
    - Silicones with reactive group
    - Stearamidomethyl pyridinium chloride
    - Stearoxymethyl pyridinium chloride
    - Wax albumin + wax casein
- D. Dyeing
  - Dye accelerants or carriers
    - Aromatic esters and ethers
    - Biphenyl
    - Butyl benzoate
    - Butyl benzyl benzoate
    - Chlorobenzenes
    - Cyclo-carbolic acid esters
    - Methyl salicylate
    - Methyl or dimethyl phthalates
    - o- and p-phenyl phenol
    - Phenyl methyl carbinol
    - Phosphated esters
    - Salicylic and benzoic acids
    - Orthophenylphenol
  - Dye correctives
    - Aromatic and alkylated aryl amines
    - Diaryl- and alkaryl-substituted alkylenediamines
    - Diphenyl ethylene diamine
    - Formaldehyde
    - Glyoxals
    - Urea- and melamine-formaldehyde resins
    - Zinc, magnesium, and aluminum salts of acetates and formates
  - Dulling agents
    - Soap cresylic acid
    - Soap-pine oil emulsions
  - Viscosity stabilizers
    - Sodium hexametaphosphate
    - Tetra-sodium pyrophosphate
  - Acid-producing agents (carpet printing paste)
    - Acetic acid
    - Citric acid
    - Formic acid
    - Tartaric acid
  - Antifrosting agents (carpet printing paste)
    - Diethanolamide
  - Thickening agents for printing pastes
    - Alginates
    - Cellulose ethers
    - Copolymer of acrylamide and N-t-butyl acrylamide
    - Dextrin
    - Esters of phosphoric acid with oxyethylated wax alcohols
    - Esters of polyethylene glycol with long chain fatty acid and/or phosphoric acid
    - Ethylene oxide (modifier of starch)
    - Guar gums

Table 3. (Cont.) TYPICAL RAW MATERIALS USED IN THE FABRIC TREATMENT INDUSTRY

Thickening agents for printing pastes (cont.)
- Gum arabic
- Gum traga earth
- Gum tragasol
- Polyacrylamide
- Polyacrylic acids
- Starches

Antifoaming agents
- Alkylene oxide derivatives
- Fatty acid amides
- Fatty acids and esters
- Higher alcohols
- Hydrocarbon oils
- Methyl isobutyl carbinol
- Organic phosphates
- Terpins

Softening agents and detergents
- Emulsions of oils, fats, and waxes
- Fatty acid condensation products
- Soaps
- Substituted ammonia complexes
- Sulfated alcohols
- Sulfonated oil
- Nonylphenoxypolyethyleneoxyethanol

Solubilizing agents (carpet printing paste)
- Diethylene
- Glycol esters
- Triodiglycol
- Urea

E. Carpet Backing

Adhesives/carpet backing latices
- Acetate polymer and copolymers
- Copolymers of styrene/butadiene and styrene/isoprene
- Natural and synthetic rubbers
- Polyacrylates
- Vinyl chloride
- Butadiene-acrylonitrile latexes
- Polyethylene
- Ethylene-vinyl acetate copolymers

The surface coating industry classifies the surface coatings by the chemical type of the film former (alkyd paint, acrylic lacquer, etc.).[3]

b. Pigments - Pigments are used for color and opacity.[3] However, they are also used for fillers, reinforcers, corrosion inhibitors, and mildew control. Pigments consist of both inorganic (titanium dioxide, zinc oxide, carbon black, etc.) and organic compounds (phthalocyanine, azo and non-azo pigments, etc.).

c. Solvents - Solvents are used to reduce the viscosity of the surface coating for easier handling and application. They influence setting rate, drying time, flow properties, and flammability. The solvents used are either petroleum derivatives (hydrocarbons, oxygenated hydrocarbons, chlorinated hydrocarbons, etc.) or water.[3]

d. Additives - Additives are used to facilitate production and to improve the application and performance properties of the coating system. Additives consist of surface agents, driers, thickeners, flow modifiers, anti-skinning agents, fungicides, flame retardants, etc.

2. Uses

Surface coatings are marketed through both trade sales and industrial sales. A brief discussion of the products in each of these categories follows.

a. Trade Sales - Trade sales include all stock-type commodities (shelf goods) which are distributed through wholesale/retail channels. Trade sales comprise three different categories: interior and exterior finishes, and miscellaneous paint products.

Interior water base paints include flat wall paint, semigloss enamel, paste and semipaste systems, casein and calcimine paints, concrete finishes, and stains. Interior oil base paints include gloss and semigloss enamel, flat wall paint, varnish, primer and sealer, aerosols, antique kit coatings, stains, tile-like coatings, flooring systems, multicolored paints, colorants, and specialty enamels.

Exterior water base paints include house paint, paste and semipaste systems, stains, and patio finishes. Exterior oil base paints include house paints, enamel, primer and sealer, barn and fence paints, roof and driveway coatings, metallic pigmented paints, stains, gutter and downspout paints, swimming pool paints, and varnishes.

Miscellaneous paints include automotive refinishing paints, traffic paint, government specification paints, and marine paints for the refinishing of pleasure craft.

b. Industrial Sales - Industrial sales include all products specifically formulated to meet the conditions of application and use of the article or substrate to which it is applied. Industrial sales are classified according to product finishes and industrial finishes.

Industrial product finishes include automotive paints (excluding finishes for trucks and buses), wood furniture and fixture coatings (includes stains, sealers, and topcoats), metal container paints (includes metal cans, drums, barrels, and collapsible tubing), metal furniture and fixture paints, appliances (includes heating and air conditioning equipment, as well as major and minor appliances), machinery and equipment paints, paper, film and foil coatings, sheet, strip, and coil coatings, factory finished wood, non-automotive transportation, electrical insulation, and coatings for toys, sporting goods, gym and baby equipment, screens, structural steel, metal parts, glass, leather, plastics, and fabrics.

Maintenance finishes include oil interior and exterior coatings specially formulated for specific exposure needs. Maintenance marine finishes include original finishes for commercial and pleasure craft as well as refinishing systems for commercial craft. Those maintenance finishes which are sold through wholesale/retail outlets are excluded.

C. INDUSTRIAL SURFACE COATING PROCESSES

1. General

Industrial product finishing plants utilize one or more of the following processing steps: degreasing, surface coating, and drying and curing.

2. Industrial Painting Operations

a. Degreasing - During the fabrication of metal products, such as refrigerators, metal furniture, small appliances, etc., the metal surface is lubricated with oils, greases, or stearates to facilitate the various drawing, forming, and machining operations. These lubricants, together with dust particles and dirt, must be removed from the metal surface prior to surface coating. This degreasing operation is used to ensure that the surface coating adheres to the metal surface.[4,5]

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[4] Air Pollution Engineering Manual, AP-40, Second Edition, U.S. Environmental Protection Agency, May 1973.

[5] Payne, H. F. Organic Coating Technology, Volume 2, John Wiley and Sons, New York, N.Y., 1961.

Degreasing operations are carried out in units using halogenated hydrocarbons. Halogenated hydrocarbon solvents are used and these are listed below.[4]

Solvent	Formula	Boiling Point
Trichloroethylene	$ClHC=CCl_2$	87°C
1,1,1-Trichloroethane	CH_3CCl_3	74°C
Perchloroethylene	$Cl_2C=CCl_2$	120°C
Methylene chloride	CH_2Cl_2	40°C
Trichlorotrifluoroethane	Cl_3C-CF_3	45.8°C
or	Cl_2FC-CF_2Cl	47.7

In performing the degreasing operation, the solvent may be applied to the surface as either a liquid, a vapor, or a combination of both. Descriptions of the commercial degreasers which use these three different solvent application techniques are presented below.

Modern degreasing operations are performed in vapor spray degreasers which are designed for either batch or continuous operation.[4] Typical batch and continuous units are illustrated in Figures 3 and 4, respectively.

During degreasing, the metal parts are exposed to the solvent vapor which condenses on the cold metal surfaces. The condensed liquid dissolves the grease and drains off the metal surface. In addition, provision is made to spray the parts (either automatically or manually) with hot liquid solvent, which aids in the removal of soil. The latter operation is used when the soil components are insoluble in the solvent.[4]

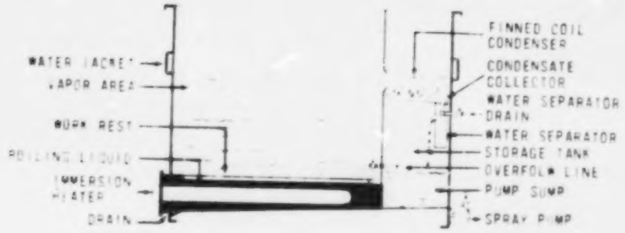
WATER JACKET
VAPOR AREA
WORK REST
BOILING LIQUID
IMMERSION HEATER
DRAIN
FINNED COIL CONDENSER
CONDENSATE COLLECTOR
WATER SEPARATOR DRAIN
WATER SEPARATOR
STORAGE TANK
OVERFOLW LINE
PUMP SUMP
SPRAY PUMP

Figure 3. Batch-type vapor-spray degreaser[4]

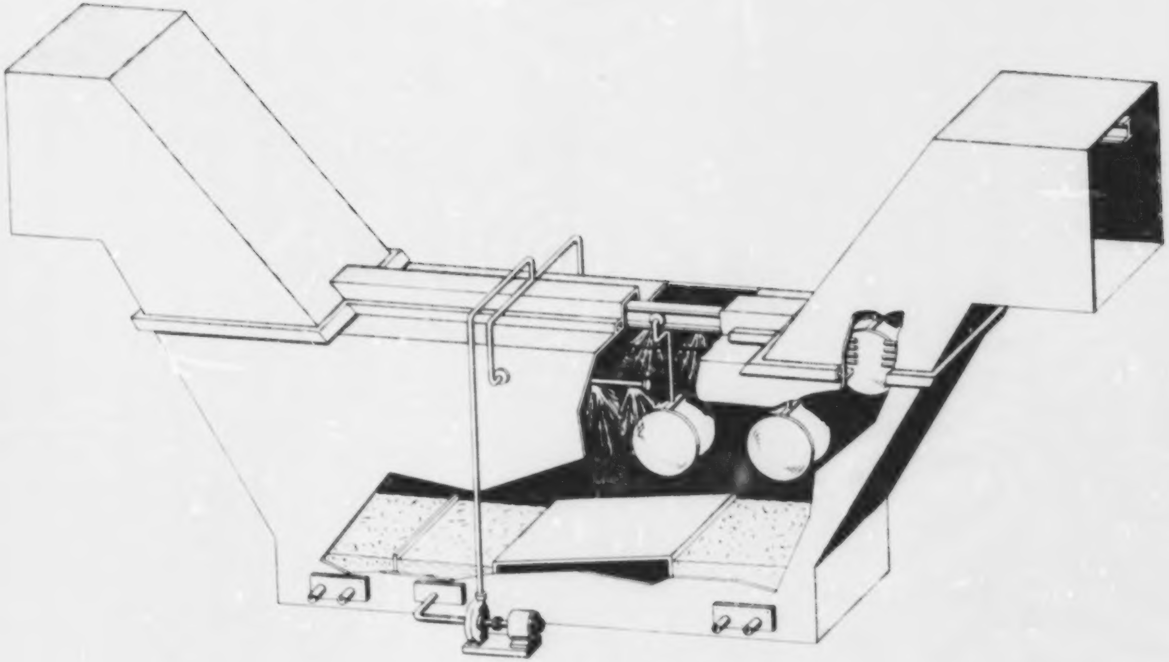

Figure 4. Continuous vapor-spray degreaser [5]

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Modifications of this basic operation are in use. For example, the metal may be immersed in warm liquid solvent followed by vapor phase degreasing. It may be immersed in boiling solvent followed by treatment in warm liquid and vapor zones. The metal parts may be agitated during immersion in the liquid solvent in order to facilitate removal of the solid contaminants.[5]

The batch-type degreaser depicted in Figure 3 consists of a tank with a heater located at the bottom to vaporize the solvent. Space above the liquid is provided for the vapor zone. Also, a "freeboard" or additional height above the vapor zone is used to minimize vapor losses.

The heat source for solvent vaporization may be an electrical immersion heater, steam, or a gas heater. The solvent vapors diffuse and fill the vapor zone. A condenser and a water jacket are located at the top of the vapor space and are used to control the height of the vapor space.

The parts to be degreased are placed in baskets and lowered into the vapor zone of the tank. The contaminated condensate from the metal parts drains back into the heated reservoir, from which it is revaporized. When necessary, the dirty parts are hand sprayed with hot solvent by means of a flexible hose which is connected to a spray pump.[4]

In the continuous vapor-spray degreaser depicted in Figure 4, the metal parts are suspended in baskets from hooks which move through the unit on a monorail. The parts pass through a vapor zone, followed by a liquid immersion section, and then another vapor zone.

Small metal parts do not require vapor degreasing. They are cleaned on a spray degreasing table. In this type of operation, it is necessary to vent the spray chamber to protect the operator from solvent vapor.[4]

Degreasing operations are also carried out in diphase systems. These consist of an aqueous phase and an organic phase. The aqueous phase removes the water-soluble contaminants which are not affected by the organic solvent. Chlorinated solvents which are used in such a system form the lower layer of the fluid since they are more dense than and immiscible with water. The degreasing operation consists of lowering the metal parts through the water layer into the solvent layer, and then reversing the operation. The cleaned part is sprayed with water to remove any remaining solvent droplets and soil particles. The operation of the system may be either manual or automatic. An automatic unit is illustrated in Figure 5.

The degreasing operation may also form an integral part of the painting process. The Du Pont "Triclene"® system is such a process and is illustrated in Figure 6. This unit includes a degreasing section, followed by a phosphatizing section, and a dip coating section. Parts to be degreased and painted move sequentially through the three sections on a conveyor. In this process, the degreasing solvent (trichloroethylene) is also used as the paint thinner. The entire process is carried out in an enclosed system and the trichloroethylene in the paint is recovered for use in the degreasing section.

b. Surface Coating - Many manufactured articles receive coatings for surface decoration and/or protection before being marketed. A number of basic coating operations are utilized for this purpose.

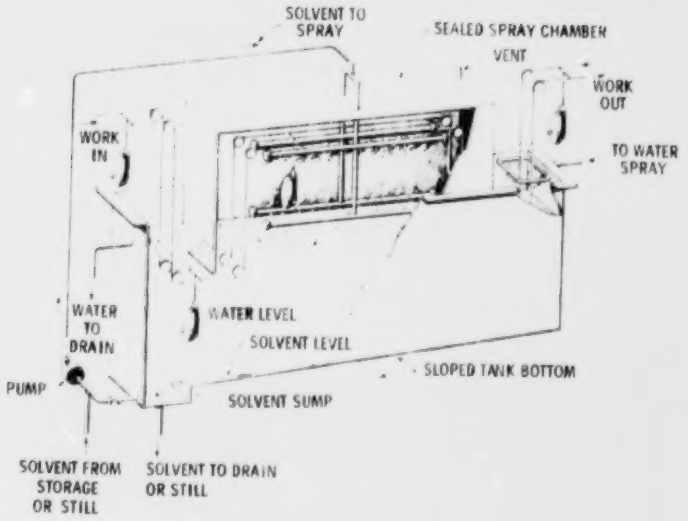
SOLVENT TO SPRAY
SEALED SPRAY CHAMBER
VENT
WORK OUT
WORK IN
TO WATER SPRAY
WATER TO DRAIN
WATER LEVEL
SOLVENT LEVEL
SLOPED TANK BOTTOM
PUMP
SOLVENT SUMP
SOLVENT FROM STORAGE OR STILL
SOLVENT TO DRAIN OR STILL

Figure 5. Continuous diphase degreaser[5]

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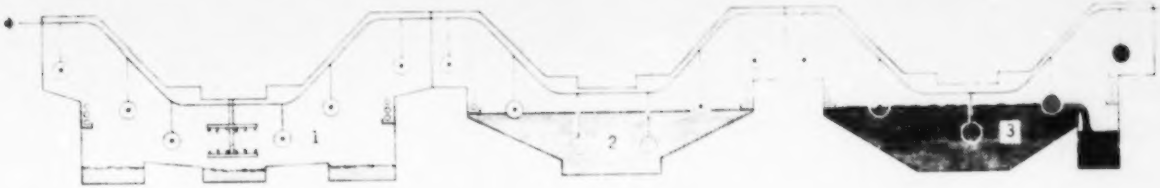

1. VAPOR DEGREASING
2. LIQUID DEGREASING
3. SURFACE COATING

Figure 6. Du Pont "Triclene"® finishing system #5[3]

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(1) Spraying - Spraying operations are performed in a booth or enclosure which is vented using a draft fan to prevent explosive or toxic concentrations of solvent vapors from forming. Such enclosures are referred to as paint spray booths, although the surface coating which is being applied may not be paint.[4]

In spraying operations, a coating material from a supply tank is forced through a nozzle which directs the coating as a spray upon the desired surface. Among the different spraying methods employed are air atomization, airless atomization, and electrostatic methods including disc, airless, and air-atomized methods.

Paint spray booths utilizing air atomization use either independent air sources or run on plant compressed air supplies. The air supplied is either heated, filtered, and/or humidified or is used without pretreatment.

Paint spray booths have one side which is open to the rest of the plant. Ventilation of the booth is required to ensure both operator and plant safety. Spray booth ventilation velocities vary from 2.8 to 4.3 meters per minute per square meter of booth opening.[4] Insurance standards require that the average velocity over the face of the booth during spraying operations be not less than 0.5 meter/sec.[4] In addition, flow into the booth must be adequate to maintain capture velocity and overcome opposing air currents. In effect, spray booths are designed and operated so that all fumes are vented through the fume hood system instead of to the remainder of the plant.

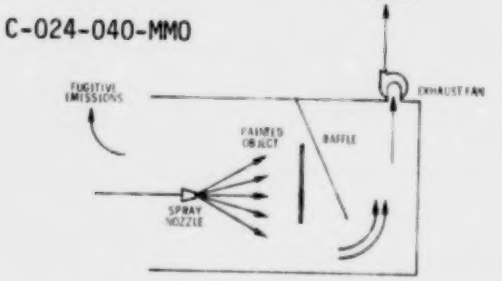
The discharge from a paint spray booth consists of particulate matter and organic solvent vapors. The particulate matter consists of entrained coating material which does not adhere to the target or the inside surfaces of the booth and its accessories. The organic vapors are generated from the evaporation of solvent, resin, diluent, and thinner.

Paint spray booths are designed for partial (50 to 98%) removal of particulates. Particulate losses are reduced by means of baffle plates, filters, or water spray curtains. Spray booths are classified according to the method employed.

Dry Baffle Spray Booth. - Baffle plates control particulates from enamel spraying by adhesion, with removal efficiencies of 50 to 90 percent. However, they have very low efficiencies in collecting lacquer spray particulates due to the rapid drying of the lacquer and consequent lack of adhesion to the baffles. A dry baffle spray booth is illustrated in Figure 7.

Paint Arrestor Spray Booth. - Filter pads remove paint particulates with efficiencies of up to 98 percent. The filtering velocity should be less than 1.3 m/sec. A paint arrestor spray booth is illustrated in Figure 8.

Water-Wash Spray Booth. - Water curtains and sprays are used for removing paint particulates, with efficiencies up to 95 percent being attainable. A water circulation rate of 1 to 5 liters per cubic meter of exhaust air is recommended. Surface active agents are added to the water to aid in the removal of paint from the circulating tank. A water-wash spray booth is illustrated in Figure 9.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GAS EXHAUST
EXHAUST FAN
FUGITIVE EMISSIONS
PAINTED OBJECT
BAFFLE
SPRAY NOZZLE

Figure 7. Dry baffle spray booth

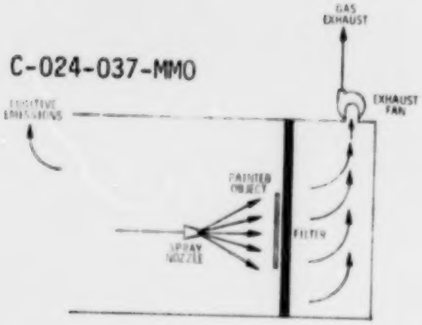
C-024-037-MMO
GAS EXHAUST
EXHAUST FAN
FUGITIVE EMISSIONS
PAINTED OBJECT
FILTER
SPRAY NOZZLE

Figure 8. Paint arrestor spray booth

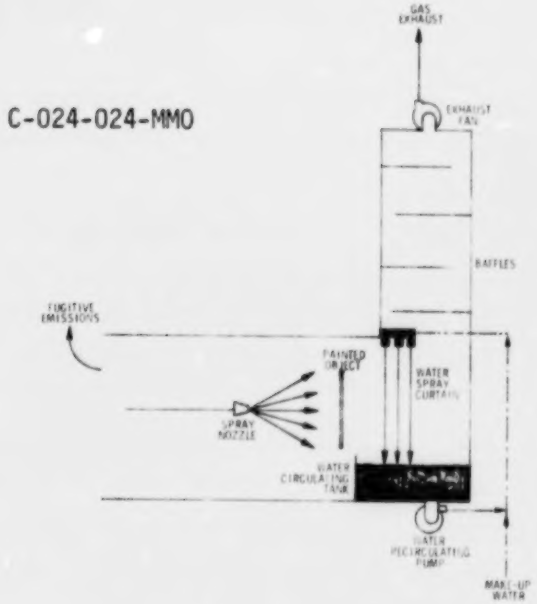
C-024-024-MMO
GAS EXHAUST
EXHAUST FAN
BAFFLES
FUGITIVE EMISSIONS
PAINTED OBJECT
WATER SPRAY CURTAIN
SPRAY NOZZLE
WATER CIRCULATING TANK
WATER RECIRCULATING PUMP
MAKE-UP WATER

Figure 9. Water-wash spray booth

(2) Dip coating - In dip coating operations, the object to be coated is immersed in a tank containing the surface coating. The object to be coated is immersed in the tank just long enough to be coated completely, and it is then removed from the tank. Excess paint drains back into the tank directly or down drain boards that return the coating material to the tank. Dip tanks are usually equipped with a close-off lid and a drainage reservoir for use in case of fire.[4]

A variation of dip coating is electrodeposition of a resinous material on surfaces. The coating material is used as an aqueous solution, suspension, or dispersion. The object being coated is the anode and the dip tank is the cathode. The dilute coating system is converted from a water soluble or dispersible form to a dense, water insoluble film on the surface being coated. Electrocoating has an advantage over other coating methods by producing a coating of uniform thickness on all wetted surfaces, including sharp edges and remote areas.[4]

(3) Flow coating - Flow coating is used on articles which cannot be dipped due to their buoyancy, such as fuel oil tanks, gas cylinders, pressure bottles, etc. In this operation, the coating material is fed through overhead nozzles which cause the paint to flow in a steady stream over the article to be coated. Excess paint drains from the coated object and is recirculated. The removal of excess coating material and solvent is aided by impinging jets of heated air.

(4) Coil coating - Coil coating is a technique for coating long, flat strips or coils of metal (generally aluminum or steel) either on one side or both by means of rollers,

similar to those of a printing press.[4] A coil coating machine contains a set of three or more power driven rollers. One of the rollers is partially immersed in the coating material. The paint is transferred to a second, parallel roller by direct contact. The sheet to be coated is run between the second and third rollers, and is coated by transfer of paint from the second roller.

(5) Powder coating - This technique is a variation of both spray painting and dip coating. In this operation, the coatings, consisting of pigment, polymer, and additives, but not solvent, are applied (1) to a grounded object by electrostatic spray gun and then heat curing the surface coating, or (2) by immersing a heated object in a fluidized bed of coating material.[6]

c. Drying and Curing - The drying and curing of applied surface coatings is achieved by both evaporation and by forced evaporation by heating. Paint baking ovens are employed for the drying, baking, curing, polymerizing, etc., of surface coatings. In all of these instances, heat is used to remove residual solvents. Also, in baking, curing, and polymerizing operations, the heat produces chemical changes (resin polymerization) which result in a hardened, toughened, less penetrable coating. A brief description of the bake ovens follows.

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[6] Background Information for Establishment of National Standards of Performance for New Sources - Paint and Varnish Manufacturing, Walden Research Corporation, Cambridge, Massachusetts, EPA Contract No. CPA 70-165, Task Order 4, October, 1971.

Before entering the bake oven, the wet, coated object is allowed to dry by natural evaporation to remove the highly volatile solvent components. This evaporation is used to prevent the formation of bubbles in the coating during drying.[4]

The forced evaporation of solvent performed in the bake ovens begins with a low temperature to provide for continued slow evaporation of residual solvent without bubbling. Sufficient time and temperature are provided for complete curing of the coating. The process is terminated before damage to the coating occurs. Volatilized curing products are removed from the vicinity of the coated surface to prevent interferences with the curing process and to prevent the concentration of organic vapors from reaching explosive levels.[4]

Bake ovens are designed for either batch or continuous operation. Batch processing is well-suited to low production rates or to prolonged, complex, or critical heating cycles. A continuous bake oven is used for high production rates.[4]

A typical batch-type oven consists of an insulated enclosure with access doors at one end, equipped with temperature-regulating, air-circulating, and exhaust systems. Coated parts are placed on portable shelves or racks which are rolled in and out of the oven. Figures 10 and 11 are schematic diagrams of batch and continuous ovens, respectively.[4]

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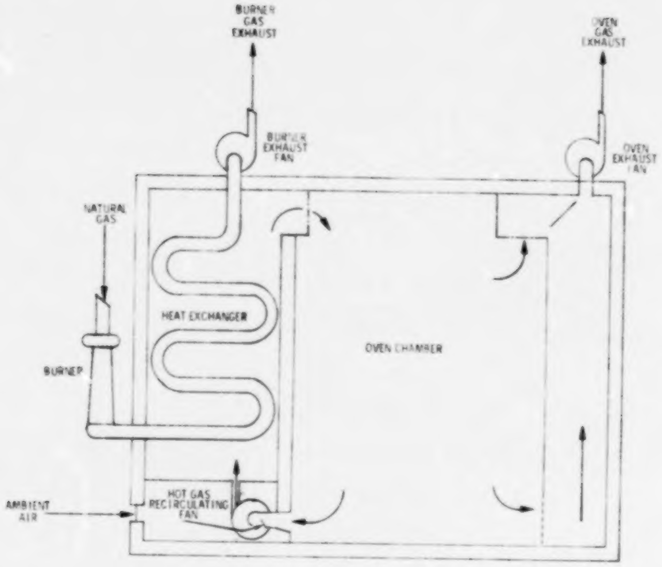
BURNER GAS EXHAUST
OVEN GAS EXHAUST
BURNER EXHAUST FAN
OVEN EXHAUST FAN
NATURAL GAS
HEAT EXCHANGER
OVEN CHAMBER
BURNER
AMBIENT AIR
HOT GAS RECIRCULATING FAN

Figure 10. Batch-type bake oven - indirect fired[4]

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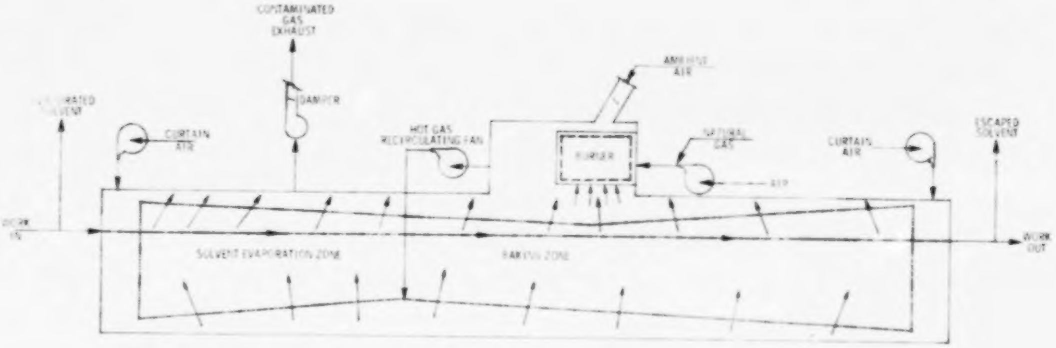
CONTAMINATED GAS EXHAUST
EVAPORATED SOLVENT
DAMPER
CURTAIN AIR
HOT GAS RECIRCULATING FAN
AMBIENT AIR
BURNER
NATURAL GAS
AIR
CURTAIN AIR
ESCAPED SOLVENT
WORK IN
SOLVENT EVAPORATION ZONE
BAKING ZONE
WORK OUT

Figure 11. Continuous bake oven - direct fired[4]

The simplest oven is a batch-type oven which occupies as little as 30 cubic meters of space. On the other hand, a large continuous oven may enclose hundreds of cubic meters of space and have provisions for maintaining several different temperature levels, air-circulation rates, and exhaust rates.[4]

Air curtains at the access openings are used to control the escape of heated, contaminated gases into work areas. In addition, an oven may have equipment to filter and precondition the make-up air supply, and may be equipped with fire- and explosion-prevention devices.[4]

The heat required by a bake oven may be supplied by gas, electric, steam, or waste heat from other processes. Ovens heated by gaseous fuels may be either direct- or indirect-fired. In a direct-fired oven, the products of combustion combine with the process air, which may be either fresh make-up air or a mixture of fresh make-up air and recirculated oven gases. In the latter case, organic materials in the recirculated oven gases come into contact with flame, and the resulting pyrolysis may cause the emissions from the oven to be more photochemically reactive than their solvent precursors. In an indirect-fired oven, the circulated air is passed through one side of a heat exchanger, while the combustion products are passed through the other side and subsequently discharged to the atmosphere. Indirect firing is used either when the explosion hazard is considered high or when combustion products in the circulated oven gases might interfere with the chemistry of the baking process.[4]

Electrically heated ovens are of two types: resistance and infrared. In the resistence type oven, fresh make-up air or oven gases are passed over resistance heaters, and the heating system is similar to a direct gas-fired type except that there are no combustion products. Infrared heating may be accomplished by means of bulb, tube, or reflected resistance heating elements. Such a system is practical only when all coated surfaces can be directly exposed to the heat sources. The infrared method of heating can reduce the energy input requirement because heat absorbed by the substrate may be minimal, the oven atmosphere absorbs little heat, and the exterior oven surface temperature may remain low, thereby minimizing heat losses to the surroundings.[4]

Steam heating of ovens is an indirect heating method in which oven gases or make-up air are heated by passage over steam coils. The method is used where the fire or explosion hazard is high. Heat discharged from other processes also may be used to meet all or part of the heating requirements of a bake oven. If the incoming hot gases contain no components which might interfere with the baking process, direct heating is practical; otherwise, indirect heating with heat exchangers must be used.[4]

The circulating system of a bake oven serves a dual purpose. It distributes the heat uniformly throughout the oven enclosure, and it increases the rate of heat transfer to the coating material by means of forced convection. The exhaust system of a bake oven is designed to remove the organic materials volatilizing from the coating to prevent this build-up to hazardous levels. The highest concentration of organics occurs at the onset of the heating process. Thus, in batch ovens, the period immediately following loading is critical, while in continuous ovens, the area near the entrance presents the greatest problem. For this reason, the exhaust duct openings are located near the entrance of a continuous oven.

3. Paper and Paperboard Coating

Paper and paperboard coating involves two processes: surface coating and drying. Degreasing of paper products prior to surface coating is not performed because lubrication of the paper is not used during any of the fabrication steps.

A process used for the surface coating of paper is similar to flow coating of metal sheet as discussed previously in this report. The process is called extrusion coating and differs from flow coating in that it utilizes solventless coatings. A description of the process follows.

Extrusion coating is a technique in which a hot polymer or wax is applied to a flexible surface.[7] The coatings which are applied include low, medium, and high density polyethylene, ethylene-vinyl acetate copolymers, polypropylene, monomers, cellophane, polyesters, and petroleum waxes.[7,8] Figure 12 is a schematic diagram of a typical extrusion coating process.

Paper to be coated is fed to the coating unit from a roll. The paper passes over several idler rolls and a preheating drum before being coated on a pressure roll. The coating is applied to paper approximately 10 centimeters before the paper is pressed between the pressure roll and the chill roll. After cooling, the paper passes over a treater roll and several idler rolls before being taken up by the windup roll.[7]

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[7] Modern Plastics Encyclopedia - 1971-1972; Vol. 48, No. 10A, McGraw-Hill, Inc., New York, New York.

[8] Modern Plastics Encyclopedia - 1973-1974; Vol. 50, No. 10A, McGraw-Hill, Inc., New York, New York.

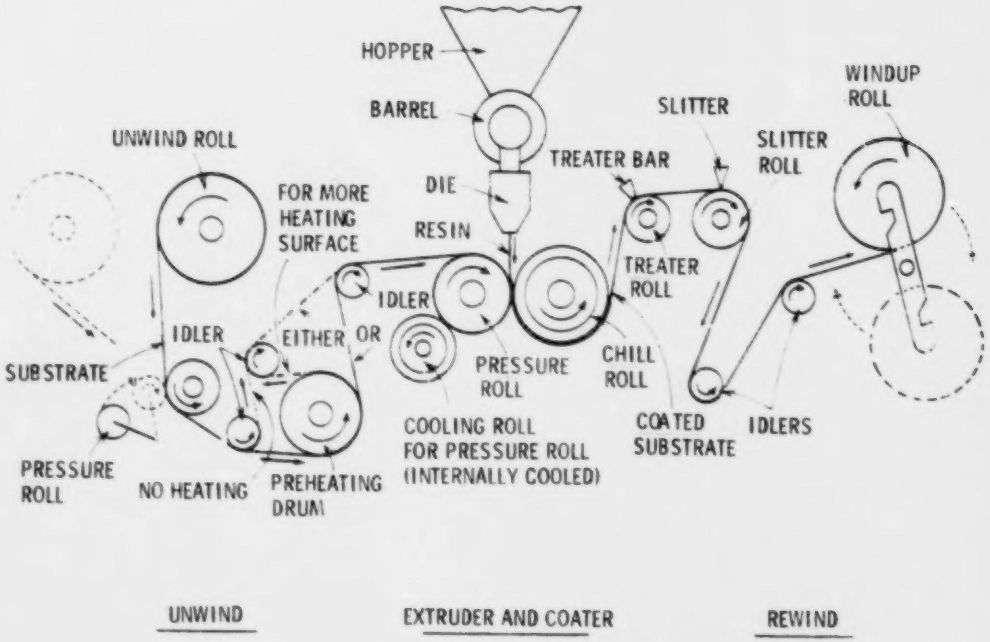
HOPPER
BARREL
WINDUP ROLL
SLITTER
UNWIND ROLL
TREATER BAR
SLITTER ROLL
DIE
FOR MORE HEATING SURFACE
RESIN
TREATER ROLL
IDLER
IDLER
EITHER
OR
CHILL ROLL
SUBSTRATE
PRESSURE ROLL
COATED SUBSTRATE
IDLERS
COOLING ROLL FOR PRESSURE ROLL (INTERNALLY COOLED)
PRESSURE ROLL
NO HEATING
PREHEATING DRUM
UNWIND
EXTRUDER AND COATER
REWIND

Figure 12. Schematic cross section of a typical extrusion coating line[7]

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The coating is fed to the unit in solid form to the hopper. The resin or wax is melted by subjecting the material to heat and pressure inside an extruder barrel. It is forced by the extruder screw through the 0.3 to 0.8 millimeter slit in the extruder die.[7]

The molten film is then drawn into the nip between the pressure roll and the water-cooled chill roll. The thickness of the applied coating typically varies from 0.01 to 0.04 millimeters.

Temperatures in the coating extruders range from 150°C near the hopper to about 340°C in the die.[7] The extruder barrels have diameters of 6 to 20 centimeters and lengths of up to 4 meters with length-to-diameter ratios of 28 to 1.[8]

The paper speeds in the coater are about 450 meters per minute with coating feed rates of 200 to 900 kilograms per hour.[7] Drying of the coating is achieved by cooling the coating film on the chiller roll and results in the free evaporation of resin monomer and resin decomposition products formed during exposure to extruder barrel temperatures.

4. Fabric Scouring and Treatment

a. Knit Fabric Scouring - Finish oils and other contaminants are removed from all fabrics and yarns before the dyeing operation by scouring the fabric with water plus a detergent. Such a step reduces the oil content to 0.5 percent by weight or less.[9]

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[9] Matthews, J.C., Weant, G.E. III, and Kearney, J.J., Screening Study on the Justification of Developing New Source Performance Standards for Various Textile Processing Operations, Research Triangle Park, N.C., EPA Contract No. 68-02-0607-11, August, 1974.

Texturized polyester yarns are oiled prior to knitting. Oil levels of 2 to 5 percent by weight are common. Polyester is oleophilic and removal of the oil from the fiber is difficult using aqueous cleaners. An alternative scouring approach has been developed and is in current use. The method uses chlorinated solvents, usually perchloroethylene, instead of water, in what is essentially a drycleaning operation. The operation is performed in either a batch or continuous manner. Figure 13 is a schematic diagram of a continuous solvent knit scouring operation.

b. Fabric Treatment - Fabric treatment consists of two major processes: finishing, and coating.

Finishes are applied to fabrics to change, improve, or develop the appearance or desired behavior characteristics of the fabric. Development in the types and applications of chemical finishes has taken place during the past decade, and most fabrics today receive one or more special finishes. The types of finishes which are used include: shrink-proofing, crease resistance, water repellancy and water-proofing, flameproofing, stainproofing, antistatic finishes, and others.

The application of the various finishes (additives, resins, modifiers, and solvents) entails a curing step which exposes the fabric to temperatures above 200°C. At these temperatures, the solvents used as finishing component vehicles, the softeners and conditioners, and the by-products from the resin curing are volatilized from the fabric.

Coating of fabrics is a specialized finishing operation and includes operations such as plissé (puckering), glazing, sizing, and others. Many of these coatings are applied as

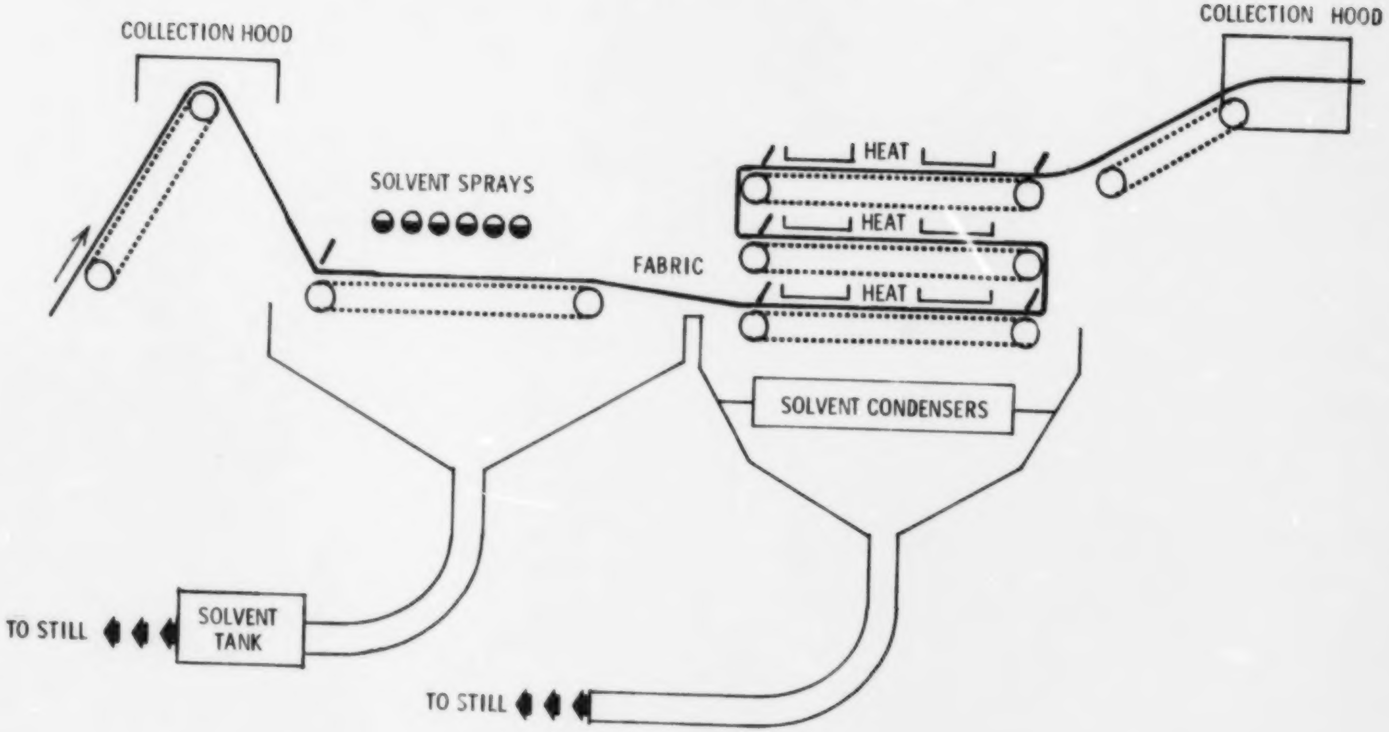
COLLECTION HOOD
SOLVENT SPRAYS
FABRIC
HEAT
HEAT
HEAT
COLLECTION HOOD
SOLVENT CONDENSERS
TO STILL
SOLVENT TANK
TO STILL

Figure 13. Continuous knit fabric scouring[9]

aqueous emulsions such as resorcinol-formaldehyde-latex formulations. The rubber-based coatings are applied from solvent based formulations such as toluene solvents.

c. Drying and Curing - Drying of fabrics occurs after scouring, dyeing, and finishing. This is achieved using both direct contact driers and by forced air drying.

Direct contact drying involves drying of the fabric on rollers which are heated using steam as a heat source. Forced air drying is similar to indirect-fired bake oven operation.

D. INDUSTRIAL SURFACE COATING - EXCLUDING AUTOMOTIVE PAINTING

Industrial surface coating processes, excluding automotive painting, have been divided into ten product-type categories (see Table 4). Each category was further divided into individual products. Tables 5 through 14 list these products or processes along with annual production figures (1972 data). Tables 15 and 16 are lists of paint and coating types and their industrial applications.

E. GEOGRAPHICAL DISTRIBUTION

In 1972, there were approximately 8,700 product-type surface coating plants in the United States each having a total sales volume of $500,000 per year or more.[59] More than 85% of the plants are located in 19 states. These states are: Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York, Massachusetts,

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[59] Thomas Register of American Manufacturers - 1973, Volumes 1-6, 10,020 pages, Thomas Publishing Company, 1973.

Table 4. INDUSTRIAL SURFACE COATING CATEGORIES BY PRODUCT TYPE

- Major appliance finishing
- Small appliance finishing
- Farm machinery finishing
- Industrial machinery finishing
- Commercial machinery finishing
- Wood furniture finishing
- Sheet, strip, and coil coating
- Metal furniture finishing
- Paper and paperboard coating
- Fabric treatment

Table 5. MAJOR APPLIANCE PRODUCTION

Appliance type	1972 Production, units	Coated surface area,[a] m^2/unit
Air conditioners	6,063,894[10]	1.75
Dehumidiifers	439,965[11]	1.75
Dishwashers	3,199,000[11]	3.00
Dryers	3,925,000[11]	6.38
Enameled plumbing fixtures	13,994,082[12]	1.97
Freezers	1,576,000[11]	9.91
Furnaces	2,697,926[10,13]	3.68
Humidifiers	1,150,000[11]	1.75
Lawnmowers	5,075,800[14]	0.84
Refrigerators	6,315,000[11]	9.91
Stoves	5,892,000[11]	3.58
Televisions and radios	23,357,000[11]	0.74
Trash compactors	150,000[a]	2.00
Washers	5,107,000[12]	4.76
Water heaters	5,436,000[11]	2.41
Water softeners	478,000[15]	0.86

[a] Estimate.

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[10] Preliminary Report, 1972 Census of Manufactures, Refrigeration and Heating Equipment, Standard Industrial Classification 3585, U.S. Department of Commerce, MC 72(P)-35G-3, March, 1974.

[11] Statistical Abstract of the United States - 1973, U.S. Department of Commerce.

[12] Preliminary Report, 1972 Census of Manufactures, Metal Sanitary Ware, Standard Industrial Classification 3431, U.S. Department of Commerce, MC 72(P)-34B-1, March, 1974.

[13] Preliminary Report, 1972 Census of Manufactures, Heating Equipment, Except Electric, Standard Industrial Classification 3433, U.S. Department of Commerce, MC 72(P)-34B-3, March, 1974.

[14] Preliminary Report, 1972 Census of Manufactures, Lawn and Garden Equipment, Standard Industrial Classification 3524, U.S. Department of Commerce, MC 72(P)-35A-4, March, 1974.

[15] Preliminary Report, 1972 Census of Manufactures, Service Industry Machinery, Standard Industrial Classification 3589, U.S. Department of Commerce, MC 72(P)-35G-5, March, 1974.

Table 6. SMALL APPLIANCE PRODUCTION

Appliance type	1972 Production, units	Coated surface area,[c] m^2/unit
Bathroom scales	5,744,000[16]	0.24
Blenders	4,300,000[11]	0.11
Can openers - knife sharpeners	10,897,400[11]	0.09
Cameras	492,500[a]	0.03
Carpet care appliances	9,331,000[11]	0.29
Coffee pots	9,000,000[11]	0.10
Electric cooking utensils	6,050,000[11]	0.12
Electric fans	9,850,000[11]	1.09
Electric razors	4,800,000[11]	0.02
Eleectric tools	15,493,900[17]	0.07
Garbage disposals	2,772,000[11]	0.27
Hair dryers	240,000[b][11]	0.38
Irons	9,150,000[11]	0.06
Lamps	15,429,000[c]	0.23
Mixers	5,150,000[11]	0.24
Movie and slide projectors	2,318,600[11]	0.28
Phonographs	5,184,000[11]	0.30
Sewing machines	1,825,000[c]	0.50
Snowblowers	269,000[14]	1.7
Space heaters	1,316,700[10,13]	0.50
Tape recorders	513,400[11]	0.15
Toasters	652,500[a][11]	0.27

[a] Data based on assumption that 10% of all production is coated.

[b] Data based on assumption that 5% of all production is coated.

[c] Estimate.

[16] Preliminary Report, 1972 Census of Manufactures, Scales and Balances, Except Laboratory, Standard Industrial Classification 3576, U.S. Department of Commerce, MC 72(P)-35F-4, March, 1974.

[17] Preliminary Report, 1972 Census of Manufactures, Power Driven Hand Tools, Standard Industrial Classification 3546, U.S. Department of Commerce, MC 72(P)-35C-5, March, 1974.

Table 7. FARM MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m^2/unit
Air-carried type power sprayers	8,088[18]	2.25
Bale throwing attachments	6,820[18]	23.2
Beet, bean, and vegetable cultivators	127[18]	4.4
Beet harvesters	728[18]	4.0
Blade terracers	102,098[18]	0.76
Boxes and racks	60,294[18]	23.0
Broadcast seeders	21,310[18]	7.1
Brooders	147,393[18]	4.73
Chisel plows	16,913[18]	0.2
Combines	21,104[18]	28.4
Corn and cotton cultivators	19,180[18]	2.0
Corn pickers	7,577[18]	2.0
Corn planters, listers, potato planters, etc.	33,959[18]	1.0
Corn shellers	7,500[a]	2.0
Cotton strippers	2,220[18]	2.0
Dairy machines	48,271[18]	5.0
Disc plows	747[18]	0.76
Dryers	16,456[18]	4.0
Egg graders	117[18]	1.0
Egg washers	262[18]	1.0
Farm elevators, portable	140,456[18]	7.92
Farm elevators, stationary	3,960[18]	15.0

[a] Estimate.

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[18] Preliminary Report, 1972 Census of Manufactures, Farm Machinery and Equipment, Standard Industrial Classification 3523, U.S. Department of Commerce, MC-72(P)-35A-3, March, 1974.

Table 7. (Cont.) FARM MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m^2/unit
Farm wagons	75,676[18]	23.2
Feed grinders	5,901[18]	6.6
Feed mixers	1,017[18]	2.0
Fertilizer distributors	24,307[18]	5.6
Field cultivators	16,386[18]	1.9
Field forage harvestors	15,173[18]	6.0
Foggers and mist sprayers	58,546[18]	1.0
Forage blowers	10,393[18]	23.2
Front and rear-mounted loaders	21,093[18]	0.5
Grain drills	10,000[a]	0.5
Hand dusters	263,465[18]	0.28
Hand sprayers	6,170,693[18]	0.28
Harrows	174,924[18]	9.9
Hay bale loaders	3,198[18]	2.1
Hay balers	27,989[18]	1.9
Hay conditioners	21,204[18]	1.7
Hay stacking attachments	16,072[18]	1.3
Hog feeding equipment	45,539[b]	13.5
Hog watering equipment	30,443[18]	6.1
Incubators	19,781[18]	3.0
Land levelers	6,339[18]	1.5
Manure pumps	3,000[a]	1.0
Manure spreaders	28,032[18]	5.6
Middlebusters and disc bedders	3,782[18]	0.6

[a] Estimate.

[b] Based on 10% being coated.

Table 7. (Cont.) FARM MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m^2/unit
Moldboard plows	44,624[18]	0.58
Mower-conditioners	21,204[18]	3.1
Mowers	18,346[18]	2.7
Nests and cages	260,752[b]	1.4
Other sprayers	37,500[a]	2.0
Peanut combines	2,341[18]	28.4
Peanut diggers	2,588[18]	5.0
Potato harvesters	654[18]	4.0
Poultry feeders	549,517[b]	4.1
Power dusters	1,240[18]	2.0
Power sprayers	27,807[18]	2.0
Rakes	14,126[18]	0.32
Rod weeders	1,616[18]	1.0
Rotary cultivators	41,248[18]	2.0
Stalk shredders	113,114[18]	3.0
Subsoilers (deep tillage)	2,514[18]	1.5
Terracing and ditching	2,112[18]	1.5
Tobacco curers	7,337[18]	0.7
Tractors	393,976[18]	9.48
Turkey feeders	88,600[a]	4.1
Turkey waterers	3,440[b]	0.74
Windrowers or swathers	8,464[18]	3.0

[a] Estimate.

[b] Based on 10% being coated.

Table 8. INDUSTRIAL MACHINERY PRODUCTION

Appliance type	1972 Production, units	Coated surface area,[a] m^2/unit
Automotive maintenance equipment	240,000[a][19]	6.0
Bakery machinery	274[20]	20
Bending and forming machines	22,014[21]	10
Bindery equipment	462[22]	20
Bleaching, drying, finishing machinery	15,000[a][23]	15
Boring machines	495[24]	8
Broaching machines	96[24]	9
Butter and cheese processing machinery	168[a][20]	20
Carding and combing machines	1,000[23]	13

[a] Estimate.

[19] Preliminary Report, 1972 Census of Manufactures, Metal Working Machinery, N.E.C., Standard Industrial Classification 3549, U.S. Department of Commerce, MC 72(P)-35C-7, March, 1974.

[20] Preliminary Report, 1972 Census of Manufactures, Food Products Machinery, Standard Industrial Classification 3551, U.S. Department of Commerce, MC 72(P)-35D-1, February, 1974.

[21] Preliminary Report, 1972 Census of Manufactures, Machine Tools, Metal-Forming Types, Standard Industrial Classification 3542, U.S. Department of Commerce, MC 72(P)-35D-5, February, 1974.

[22] Preliminary Report, 1972 Census of Manufactures, Printing Trades Machinery, Standard Industrial Classification 3555, U.S. Department of Commerce, MC 72(P)-35D-2, February, 1974.

[23] Preliminary Report, 1972 Census of Manufactures, Textile Machinery, Standard Industrial Classification 3552, U.S. Department of Commerce, MC 72(P)-35D-2, February, 1974.

[24] Preliminary Report, 1972 Census of Manufactures, Machine Tools, Metal-Cutting Types, Standard Industrial Classification 3541, U.S. Department of Commerce, MC 72(P)-35C-1, March, 1974.

Table 8. (Cont.) INDUSTRIAL MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m^2/unit
Cement making machinery	1,900[a] [25]	50
Centrifugal dryers	100[26]	50
Chain saws	1,281,000[27]	0.33
Chemical manufacturing industrial machinery	4,200[a] [25]	25
Choppers, grinders, cutters, etc.	39,600[a] [20]	10
Classifiers	413[26]	40
Clayworking machinery	1,950[a] [25]	20
Cleaning and opening machines	2,600[23]	20
Cold rolling mill machines	250[a] [28]	60
Compressors	805,100[29]	7
Concentrating tables	132[26]	25

[a] Estimate.

[25] Preliminary Report, 1972 Census of Manufactures, Special Industry Machinery, N.E.C., Standard Industrial Classification 3559, U.S. Department of Commerce, MC 72(P)-35D-6, January, 1974.

[26] Preliminary Report, 1972 Census of Manufactures, Mining Machinery, Standard Industrial Classification 3532, U.S. Department of Commerce, MC 72(P)-35B-2, March, 1974.

[27] Preliminary Report, 1972 Census of Manufactures, Woodworking Machinery, Standard Industrial Classification 3553, U.S. Department of Commerce, MC 72(P)-35D-3, January, 1974.

[28] Preliminary Report, 1972 Census of Manufactures, Rolling Mill Machinery, Standard Industrial Classification 3547, U.S. Department of Commerce, MC 72(P)-35C-6, February, 1974.

[29] Preliminary Report, 1972 Census of Manufactures, Pumps and Pumping Equipment, Standard Industrial Classification 3561, Air and Gas Compressors, Standard Industrial Classification 3563, U.S. Department of Commerce, MC 72(P)-35E-1, March, 1974.

Table 8. (Cont.) INDUSTRIAL MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m^2/unit
Concrete mixers	10,374[30]	1
Construction cranes	783[30]	30
Concrete products machinery	6,655[25]	25
Continuous mining machines	292[26]	25
Cotton ginning machinery	2,600[a]	50
Crushers	1,294[26]	40
Drilling machines	36,188[24]	6.0
Drills	11,061[26]	1
Electronic tube manufacturing	180[a][25]	20
Excavators	3,706[30]	12
Feeders	1,301[26]	30
Flexographic printing presses	56[a][22]	20
Flotation machines	578[26]	60
Flour and grain mill machines	320[a][20]	50
Flowing well equipment	69,000[a][31]	10
Foundry machinery	1,300[a][25]	30
Fruit and vegetable canning machinery	6,000[a][20]	20

[a] Estimate.

[30] Preliminary Report, 1972 Census of Manufactures, Construction Machinery, Standard Industrial Classification 3531, U.S. Department of Commerce, MC 72(P)-35B-1, March, 1974.

[31] Preliminary Report, 1972 Census of Manufactures, Oilfield Machinery, Standard Industrial Classification 3533, U.S. Department of Commerce, MC 72(P)-35B-3, March, 1974.

Table 8. (Cont.) INDUSTRIAL MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m^2/unit
Gear cutting machines	765[24]	15
Glassmaking machines	1,025[a][25]	15
Gravure printing presses	66[22]	20
Grinding and polishing machines	95,520[24]	6
Grinding mills	141[26]	50
Hoists	28,410[32]	5
Homogenizers and pasteurizers	196[a][20]	30
Hot rolling mill machines	580[28]	35
Ice cream freezers	800[a][20]	20
Industrial trucks	74,800[33]	6
Jointers, etc.	18,600[a][27]	10
Knitting machines	5,100[23]	25
Lathes	12,295[24]	8
Lathes, planers, etc.	53,900[a][27]	12
Letterset printing presses	428[22]	20
Loading, cutting and long-wall mining machines	652[26]	30
Magnetic separators	277[26]	30
Meat and poultry processing machinery	30,000[a][20]	20

[a] Estimate.

[32] Preliminary Report, 1972 Census of Manufactures, Hoists, Cranes, and Monorails, Standard Industrial Classification 3536, U.S. Department of Commerce, MC 72(P)-35B-6, March, 1974.

[33] Preliminary Report, 1972 Census of Manufactures, Industrial Trucks and Tractors, Standard Industrial Classification 3537, U.S. Department of Commerce, MC 72(P)-35B-7, March, 1974.

Table 8. (Cont.) INDUSTRIAL MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m^2/unit
Metal cleaning machinery	4,600[a][25]	40
Milling machines	19,031[24]	9
Mine cars and track	2,445[26]	40
Motorized hand trucks	28,900[33]	2
Offset lithographic presses	1,702[22]	20
Overhead cranes	20,400[30]	5
Packing, packaging, and bottling machinery	19,900[a][20]	20
Papermill machinery	520[a][34]	50
Paper and paperboard converting machinery	4,540[a][34]	10
Planers	200[a][34]	88
Plastic working machinery	8,305[25]	10
Presses	23,211[21]	20
Pulpmill machinery	122[a][34]	50
Pumps	14,379,000[29]	0.8
Punching and shearing machines	29,007[21]	10
Rebuilt pulp and papermill machinery	3,800[a][34]	50
Rod lifting machinery	26,300[a][31]	10
Rotary drilling equipment, subsurface	344,000[31]	15
Rotary drilling equipment, surface	142[31]	15

[a] Estimate.

[34] Preliminary Report, 1972 Census of Manufactures, Paper Industries Machinery, Standard Industrial Classification 3554, U.S. Department of Commerce, MC 72(P)-35D-4, March, 1974.

Table 8. (Cont.) INDUSTRIAL MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m²/unit
Sawing and cutoff machines	7,320[24]	6
Sawing machines	294,100[27]	6
Sawmill equipment	3,000[a][27]	50
Screens	3,617[26]	15
Scrubbers	84[26]	40
Shapers	38[24]	6
Shoemaking machinery	2,900[a][25]	10
Shuttle cars	630[35]	40
Spinning frames	323,600[23]	50
Sugar plant processing machinery	1,500[a][20]	50
Tapping machines	610[24]	8
Thermal dryers	38[26]	50
Tobacco manufacturing	2,000[a][25]	20
Twisting frames	221,200[23]	50
Typesetting machinery	11,020[22]	10
Veneer and plywood equipment	1,200[a][27]	20
Washing and sterilizing equipment	20[a][20]	30
Welding and cutting apparatus	47,000[a][19]	5
Wet cyclones	1,029[26]	5
Wood preparation equipment	15,200[a][34]	30
Yarn preparing machines	3,780[a][23]	15

[a] Estimate.

[35] Preliminary Report, 1972 Census of Manufactures, Typewriters, Office Machines, N.E.C., Standard Industrial Classification 3579, U.S. Department of Commerce, MC 72(P)-35F-1, March, 1974.

Table 9. COMMERCIAL MACHINERY PRODUCTION

Equipment type	1972 Production, units	Coated surface area,[a] m^2/unit
Accounting machines	50,000[a][35]	0.63
Adding machines	505,002[35]	0.20
Cash registers	200,000[a][35]	0.75
Check handling machines	178,500[36]	0.80
Commercial carpet sweepers	20,600[15]	0.40
Commercial dishwashers	25,200[15]	6
Commercial floor waxers	66,400[15]	0.4
Dictating machines	193,200[36]	0.34
Duplicating machines	65,900[36]	7.4
Electronic calculators	221,470[35]	0.035
Forms handling equipment	85,700[36]	1
Gasoline pumps	78,100[37]	4.4
Industrial water softeners	21,900[15]	13.9
Mailing machines	432,800[36]	0.5
Mailing and parcel post scales	950,800[16]	0.5
Motor truck scales	1,900[16]	50
Retail and commercial scales	16,600[16]	1
Time recorders	133,500[36]	0.5
Typewriters	1,680,000[a][36]	0.75
Vending machines	503,584[38]	11.3

[a] Estimate.

[36] Preliminary Report, 1972 Census of Manufactures, Calculating and Accounting Machines, Standard Industrial Classification 3574, U.S. Department of Commerce, MC 72(P)-35F-3, March, 1974.

[37] Preliminary Report, 1972 Census of Manufactures, Measuring and Dispensing Pumps, Standard Industrial Classification 3586, U.S. Department of Commerce, MC 72(P)-35G-4, March, 1974.

[38] Preliminary Report, 1972 Census of Manufactures, Automatic Merchandising Machines, Standard Industrial Classification 3581, U.S. Department of Commerce, MC 72(P)-35G-1, February, 1974.

Table 10. WOOD FURNITURE PRODUCTION

Furniture type	1972 Production, units	Coated surface area,[a] m^2/unit
Bedroom furniture	16,933,000[39]	2.15
Bookcases	246,000[a][39]	4.35
Cabinets	10,141,000[39]	2.01
Chairs	9,938,000[39]	0.65
Desks	690,000[39]	4.41
Tables	11,070,000[39]	1.91

[a] Estimate.

[39] U.S. Department of Commerce, 1967 Census of Manufactures.

Table 11. SHEET, STRIP, AND COIL COATING

Product	1972 Production	Coated surface area[a]
Aluminum siding and roofing	215,000 tonnes[40]	115 m^2/tonne
Beer and soft drink bottle caps	3.32×10^{10} caps[41]	5.1×10^{-4} m^2/cap
Beverage cans	3.74×10^{10} cans[42]	0.645 m^2/can
Canopies and awnings	1,500,000 units[a][40]	105 m^2/ton
Door and window frames	38,102,500 units[43]	0.202 m^2/unit
Ductwork	2,360,000 tonnes[a][40]	231 m^2/tonne
Fencing	500,000 tonnes[44,45]	110 m^2/tonne
Garage doors	388,900 units[43]	20.8 m^2/unit
Gutters	126,000 tonnes[40]	231 m^2/tonne
Metal cans excluding beverage cans	3.9×10^{10} cans[42]	0.0645 m^2/can
Metal doors	6,975,000 units[43]	4.32 m^2/unit
Railings, fire escapes, staircases	115,500 tonnes[44]	29 m^2/tonne
Screening	53,580,000 m^2[45]	1 m^2/m^2
Shelving	455,000 m^2[a]	1 m^2/m^2
Steel shipping barrels	38,194 units[46]	7.66 m^2/unit
Wire products	15,000,000 m[a]	0.013 m^2/m
Wood paneling	1.7×10^8 m^2[a]	1 m^2/m^2

[a] Estimate.

[40] Preliminary Report, 1972 Census of Manufactures, Sheet Metalwork, Standard Industrial Classification 3444, U.S. Department of Commerce, MC 72(P)-34C-4, March, 1974.

[41] Preliminary Report, 1972 Census of Manufactures, Crowns and Closures, Standard Industrial Classification 3466, U.S. Department of Commerce, MC 72(P)-34D-6, December, 1973.

[42] Preliminary Report, 1972 Census of Manufactures, Metal Cans, Standard Industrial Classification 3411, U.S. Department of Commerce, MC 72 (P)-34A-1, March, 1974.

[43] Preliminary Report, 1972 Census of Manufactures, Metal Doors, Sash, and Trim, Standard Industrial Classification 3442, U.S. Department of Commerce, MC 72(P)-34C-2, March, 1974.

[44] Preliminary Report, 1972 Census of Manufactures, Architectural Metalwork, Standard Industrial Classification 3446, U.S. Department of Commerce, MC 72(P)-34C-5, February, 1974.

[45] Preliminary Report, 1972 Census of Manufactures, MIscellaneous Fabricated Wire Products, Standard Industrial Classification 3496, U.S. Department of Commerce, MC 72(P)-34F-4, February, 1974.

[46] Preliminary Report, 1972 Census of Manufactures, Metal Barrels, Drums, and Pails, Standard Industrial Classification 3412, U.S. Department of Commerce, MC 72(P)-34A-2, March, 1974.

Table 12. METAL FURNITURE PRODUCTION

Furniture type	1972 Production, units	Coated surface area,[a] m^2/unit
Bookcases	246,000[a] [39]	5.72
Cabinets	380,000[a] [39]	6.50
Chairs	13,656,800[39]	0.88
Coat racks	5,300,000[a] [39]	1.0
Desks	1,380,000[39]	13.73
File cabinets	3,775,100[39]	6.58
Safes and vaults	1,103,800[39]	3.44
Tables	3,769,600[39]	3.23
Waste cans	21,100,000[39]	0.06

[a] Estimate.

Table 13. PAPER AND PAPERBOARD COATING

Product	1972 Production, tonnes	Coated surface area, m^2/tonne
Coated paper	739,078[47]	23,800
Folding cartons	2,358,000[48]	6,000
Kraft paper	3,562,400[49]	1,900
Milk carton board	912,643[48]	595
Paper bags	3,017,700[50]	24,300
Paper boxes	16,701,400[51]	3,000
Paper cans, tubes, and drums	856,850[48]	6,000
Printing paper	3,216,800[49]	24,300
Waxed paper	118,000[47]	99,200

[47] Preliminary Report, 1972 Census of Manufactures, Paper Coating and Glazing, Standard Industrial Classification 2641, U.S. Department of Commerce, MC 72(P)-26B-1, March, 1974.

[48] Preliminary Report, 1972 Census of Manufactures, Paperboard Mills, Standard Industrial Classification 2631, U.S. Department of Commerce, MC 72(P)-26A-3, March, 1974.

[49] Preliminary Report, 1972 Census of Manufactures, Papermills, Except Building Paper, Standard Industrial Classification 2621, U.S. Department of Commerce, MC 72(P)-26A-2, March, 1974.

[50] Preliminary Report, 1972 Census of Manufactures, Bags, Except Textile Bags, Standard Industrial Classification 2643, U.S. Department of Commerce, MC 72(P)-26B-3, March, 1974.

[51] Preliminary Report, 1972 Census of Manufactures, Folding Paperboard Boxes, Standard Industrial Classification 2651, U.S. Department of Commerce, MC 72(P)-26C-1, January, 1974.

Table 14. FABRIC TREATMENT

Product	1972 Production, linear meters	Coated surface area, m^2/m
Dyeing	4.377×10^9 [52,53,54,55,56,57]	1.07
Permanent crispness	6.236×10^7 [52,53,54,55,56,57]	1.07
Sizing	9.97×10^9 [52,53,54,55,56,57]	1.07
Waterproof and water finishes	6.218×10^{7a} [52,53,54,55,56,57]	1.07
Wrinkle resistant finishes	1.061×10^{9a} [52,53,54,55,56,57]	1.07

[a] Estimate.

[52] Preliminary Report, 1972 Census of Manufactures, Weaving Mills, Cotton, Standard Industrial Classification 2211, U.S. Department of Commerce, MC 72(P)-22A-1, March, 1974.

[53] Preliminary Report, 1972 Census of Manufactures, Weaving Mills, Manmade Fiber and Silk, Standard Industrial Classification 2221, U.S. Department of Commerce, MC 72(P)-22A-2, March, 1974.

[54] Preliminary Report, 1972 Census of Manufactures, Weaving and Finishing Mills, Wool, Standard Industrial Classification 2231, U.S. Department of Commerce, MC 72(P)-22A-3, March, 1974.

[55] Preliminary Report, 1972 Census of Manufactures, Finishing Plants, Cotton, Standard Industrial Classification 2261, U.S. Department of Commerce, MC 72(P)-22C-1, March, 1974.

[56] Preliminary Report, 1972 Census of Manufactures, Finishing Plants, Manmade Fiber and Silk Fabric, Standard Industrial Classification 2262, U.S. Department of Commerce, MC 72(P)-22C-2, March, 1974.

[57] Preliminary Report, 1972 Census of Manufactures, Coated Fabrics, Not Rubberized, Standard Industrial Classification 2295, U.S. Department of Commerce, MC 72(P)-22F-5, March, 1974.

Table 15. INDUSTRIAL USES OF VARIOUS PAINTS AND COATINGS[3,58]

Paint or coating type	Industrial uses
Acrylic enamel coating	Major appliances Small appliances Metal furniture Sheet, strip, and coil coatings
Acrylic lacquer coatings	Metal furniture Wood furniture
Alkyd enamel coatings	Farm machinery Industrial machinery Major appliances Small appliances Sheet, strip, and coil coatings Paper and paperboard
Cellulosic coatings	Wood furniture Paper and paperboard Sheet, strip, and coil coatings
Epoxy coatings	Sheet, strip, and coil coatings Major appliances Small appliances Industrial machinery
Urethane coatings	Sheet, strip, and coil coatings Fabric treatment Paper and paperboard
Vinyl coatings	Sheet, strip, and coil coatings Major appliances Small appliances Industrial machinery Metal furniture
Melamine-formaldehyde	Fabric treatment
Urea-formaldehyde	Fabric treatment
Acetone-formaldehyde	Fabric treatment
Phenol-formaldehyde	Fabric treatment
Polyamides	Fabric treatment
Ethyl imine	Fabric treatment
Silicon resins	Fabric treatment

[58] Speel, Henry C., and Schwarz, E. W. K., Textile Chemicals and Auxiliaries, Second Edition, Reinhold Publishing Company, New York, N. Y., 1957.

Table 16. SURFACE COATING TYPES USED FOR INDUSTRIAL SURFACE COATING OPERATIONS[3]

	Surface Coating Type							
Product category	Alkyd enamel	Vinyl	Acrylic enamel	Acrylic lacquer	Baking enamel	Epoxy	Urethane	Nitrocellulosic lacquer
Major appliances	35.0%	-	40.0%	-	-	25.0%	-	-
Small appliances	40.0%	5.0%	40.0%	10.0%	-	-	5.0%	-
Farm machinery	100.0%	-	-	-	-	-	-	-
Industrial machinery	90.0%	5.0%	-	-	-	5.0%	-	-
Commercial machinery	90.0%	5.0%	-	-	-	5.0%	-	-
Wood furniture	72.0%	-	-	-	-	-	-	28.0%
Sheet, strip & coil	21.1%	50.0%	7.3%	0.5%	4.7%	13.0%	1.8%	1.6%
Metal furniture	67.6%	30.6%	1.8%	-	-	-	-	-

Connecticut, California, Oregon, Washington, Tennessee, North Carolina, Texas, and New Jersey. The other 15% of the plants are located in the remaining 31 states. Only two of the states did not have product-type surface coating plants; these were Alaska and Wyoming.[10]

Table 17 summarizes the number of product-type surface coating plants by product-type category for each of the fifty states. Figure 14 is a graphical presentation of the geographical distribution of product-type surface coating plants.

F. MATERIALS FLOW DIAGRAMS

Materials flow diagrams were generated from data obtained from the 1972 Census of Manufactures, the Chemical Economics Handbook, and the National Paint and Coatings Association. These diagrams were formulated for the Paints and Allied Products, Paper and Paperboard Coating, and Fabric Treatment industries. These diagrams show the raw materials flow for 1972.

Figure 15 is the raw materials diagram for the Paints and Allied Products industry. Figure 16 is the solvent flow diagram for the Paints and Allied Products industry. Figure 17 is the raw materials flow diagram for the Paper and Paperboard Coating Industry. Figure 18 is the raw materials flow diagram for the Fabric Treatment industry.

Table 17. SUMMARY OF PRODUCT-TYPE SURFACE COATING PLANTS[59]

State	Major appliance finishing	Small appliance finishing	Farm machinery finishing	Industrial machinery finishing	Commercial furniture finishing	Wood furniture finishing	Sheet strip, and coil coating	Metal furniture finishing	Paper and paperboard	Fabric treatment	Total
Alabama	3	1	-	16	-	1	9	2	3	10	45
Alaska	-	-	-	-	-	-	-	-	-	-	-
Arizona	1	-	-	3	1	-	-	-	-	-	5
Arkansas	2	-	2	5	2	8	3	-	5	3	30
California	44	37	31	149	27	8	42	19	32	16	405
Colorado	2	2	9	39	2	-	4	-	1	3	62
Connecticut	11	16	9	125	16	-	48	3	24	20	272
Delaware	-	-	-	12	-	-	3	1	2	4	22
Florida	2	-	12	25	4	2	7	-	6	-	58
Georgia	5	2	24	17	3	3	2	4	4	29	93
Hawaii	-	-	-	2	-	-	-	-	-	-	2
Idaho	-	-	5	2	-	-	-	-	2	-	9
Illinois	46	87	195	325	55	11	97	60	70	15	961
Indiana	25	15	26	70	5	25	24	26	19	7	242
Iowa	26	5	86	32	4	5	5	15	6	1	185
Kansas	4	-	29	15	2	-	8	3	-	-	61
Kentucky	16	6	2	17	2	3	9	8	5	1	69
Louisiana	-	-	1	13	-	-	7	-	8	1	30
Maine	-	-	1	13	-	3	3	1	6	3	30
Maryland	8	2	2	26	5	3	13	1	9	6	75
Massachusetts	12	13	3	165	21	11	38	14	37	45	359
Michigan	34	18	35	246	16	20	40	45	23	6	483
Minnesota	10	19	81	79	16	2	11	10	19	8	255
Mississippi	4	-	1	7	1	4	2	-	8	-	27
Missouri	9	24	19	65	11	4	22	10	13	5	182

Table 17. (Cont.) SUMMARY OF PRODUCT-TYPE SURFACE COATING PLANTS[59]

State	Major appliance finishing	Small appliance finishing	Farm machinery finishing	Industrial machinery finishing	Commercial furniture finishing	Wood furniture finishing	Sheet strip, and coil coating	Metal furniture finishing	Paper and paperboard	Fabric treatment	Total
Montana	-	-	-	1	-	1	-	1	2	-	5
Nebraska	-	1	29	14	-	1	4	-	2	-	51
Nevada	-	-	-	5	-	-	1	-	-	-	6
New Hampshire	-	-	-	16	1	2	5	-	3	6	33
New Jersey	26	34	20	259	30	1	84	19	55	22	550
New Mexico	-	-	-	2	-	-	-	-	-	-	2
New York	71	91	57	339	55	41	136	105	100	83	1078
North Carolina	1	1	31	39	1	22	9	7	7	40	158
North Dakota	-	-	14	-	-	-	-	-	-	-	14
Ohio	55	39	79	469	43	14	91	56	53	44	943
Oklahoma	4	4	12	17	1	1	4	1	3	-	47
Oregon	9	1	16	56	-	3	10	1	11	-	107
Pennsylvania	37	37	57	357	19	21	112	62	42	11	755
Rhode Island	2	-	-	14	-	1	12	-	7	13	49
South Carolina	-	1	1	17	-	6	2	1	7	30	65
South Dakota	-	-	-	-	-	-	-1	-	-	-	1
Tennessee	15	4	12	29	4	5	11	4	6	12	102
Texas	12	5	28	86	3	4	14	6	6	1	165
Utah	-	-	-	5	-	-	-	-	-	-	5
Vermont	-	3	-	12	1	1	2	-	2	-	21
Virginia	5	3	4	20	-	17	14	3	11	3	80
Washington	1	3	15	72	3	6	9	2	6	-	117
West Virginia	-	-	-	11	-	-	6	7	1	-	25
Wisconsin	35	34	74	185	8	4	22	20	37	3	422
Wyoming	-	-	-	-	-	-	-	-	-	-	-
TOTALS	537	508	1022	3493	362	264	946	517	663	451	8763

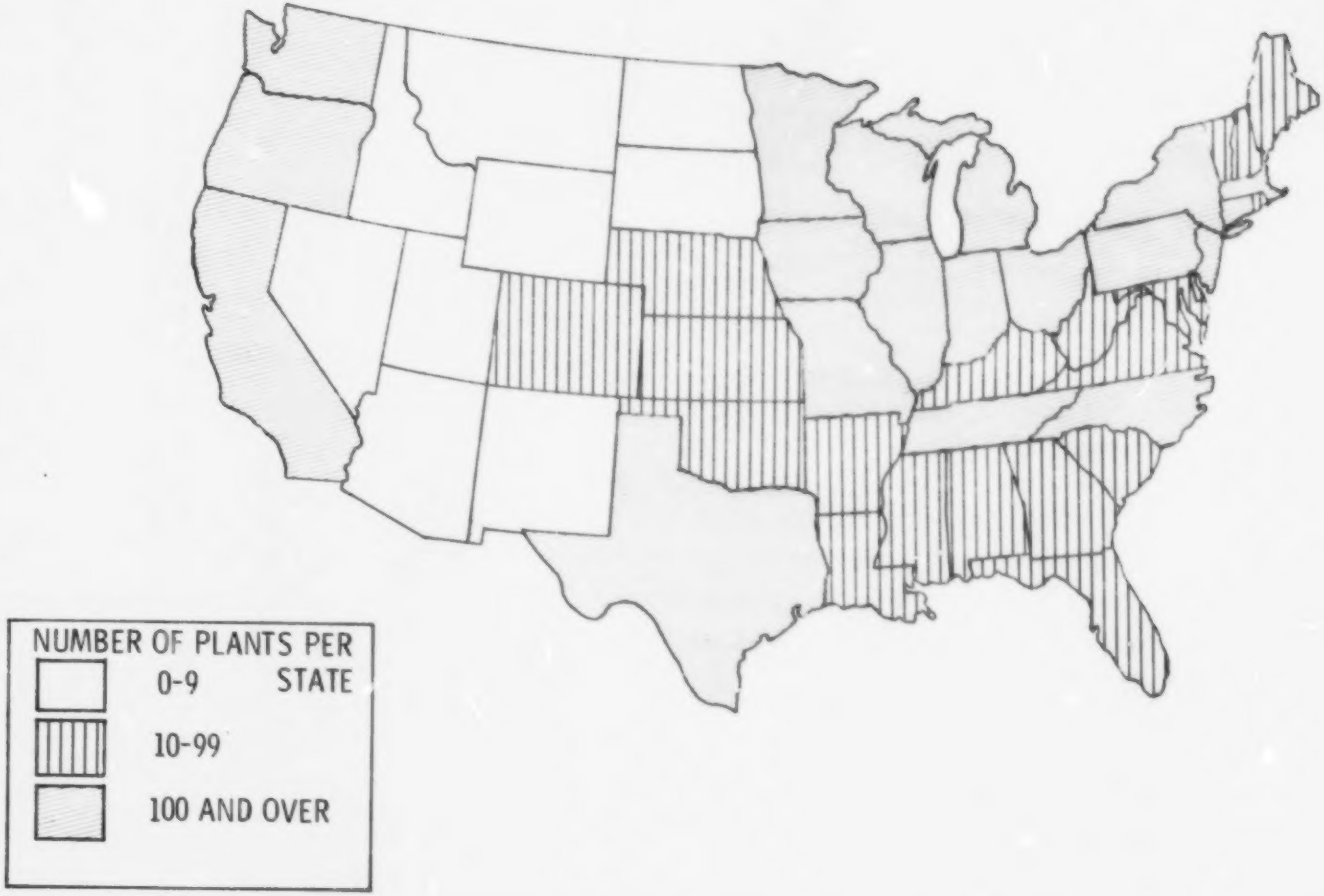
NUMBER OF PLANTS PER STATE
0-9
10-99
100 AND OVER

Figure 14. Geographical distribution of product surface coating plants by state

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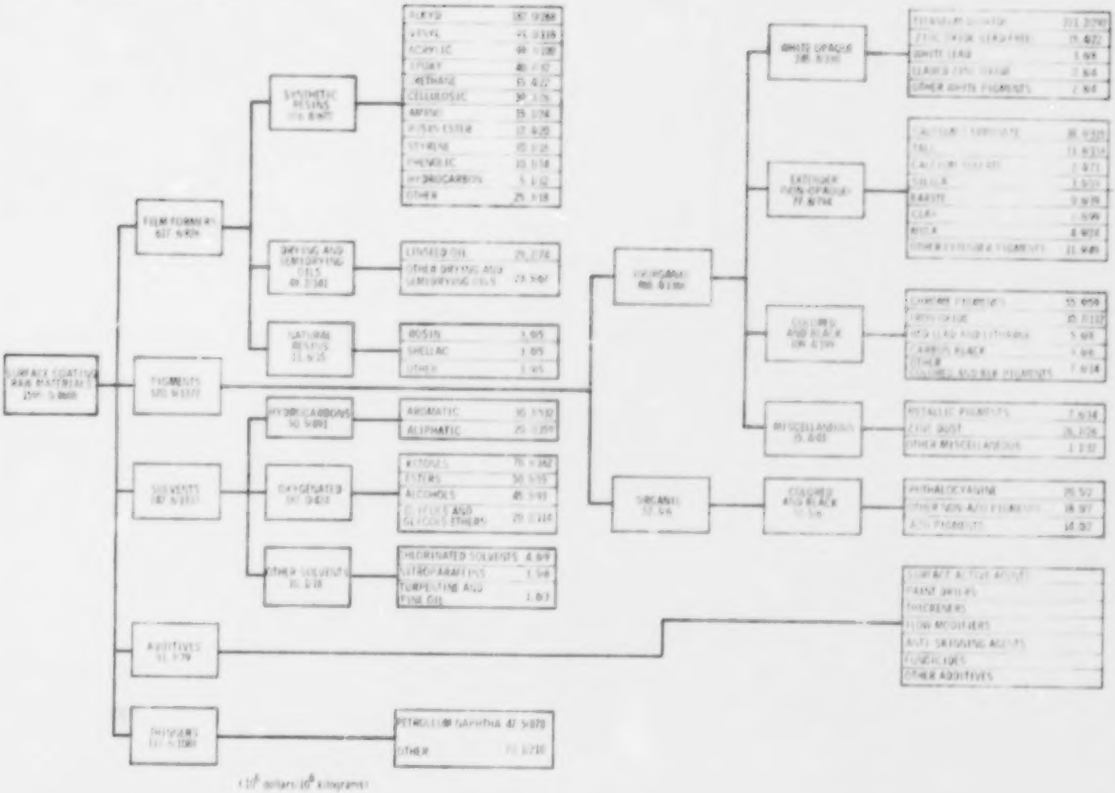

SURFACE COATING RAW MATERIALS
FILM FORMERS
SYNTHETIC RESINS
ALKYD
VINYL
ACRYLIC
EPOXY
URETHANE
CELLULOSIC
AMINO
ROSIN ESTER
STYRENE
PHENOLIC
HYDROCARBON
OTHER
DRYING AND SEMIDRYING OILS
LINSEED OIL
OTHER DRYING AND SEMIDRYING OILS
NATURAL RESINS
ROSIN
SHELLAC
OTHER
PIGMENTS
SOLVENTS
HYDROCARBONS
AROMATIC
ALIPHATIC
OXYGENATED
KETONES
ESTERS
ALCOHOLS
GLYCOLS AND GLYCOLS ETHERS
OTHER SOLVENTS
CHLORINATED SOLVENTS
NITROPARAFFINS
TURPENTINE AND PINE OIL
ADDITIVES
THINNERS
PETROLEUM NAPHTHA
OTHER
INORGANIC
WHITE OPAQUE
TITANIUM DIOXIDE
ZINC OXIDE (LEAD FREE)
WHITE LEAD
LEADED ZINC OXIDE
OTHER WHITE PIGMENTS
EXTENDER (NON-OPAQUE)
CALCIUM CARBONATE
TALC
CALCIUM SILICATE
SILICA
BARITE
CLAY
MICA
OTHER EXTENDER PIGMENTS
COLORED AND BLACK
CHROME PIGMENTS
IRON OXIDE
RED LEAD AND LITHARGE
CARBON BLACK
OTHER COLORED AND BLK PIGMENTS
MISCELLANEOUS
METALLIC PIGMENTS
ZINC DUST
OTHER MISCELLANEOUS
ORGANIC
COLORED AND BLACK
PHTHALOCYANINE
OTHER NON-AZO PIGMENTS
AZO PIGMENTS
SURFACE ACTIVE AGENTS
PAINT DRIERS
THICKENERS
FLOW MODIFIERS
ANTI SKINNING AGENTS
FUNGICIDES
OTHER ADDITIVES
(10^6 dollars/10^6 kilograms)

Figure 15. Raw materials flow diagram for the paints and allied products industry

C-024-020-BSO-1

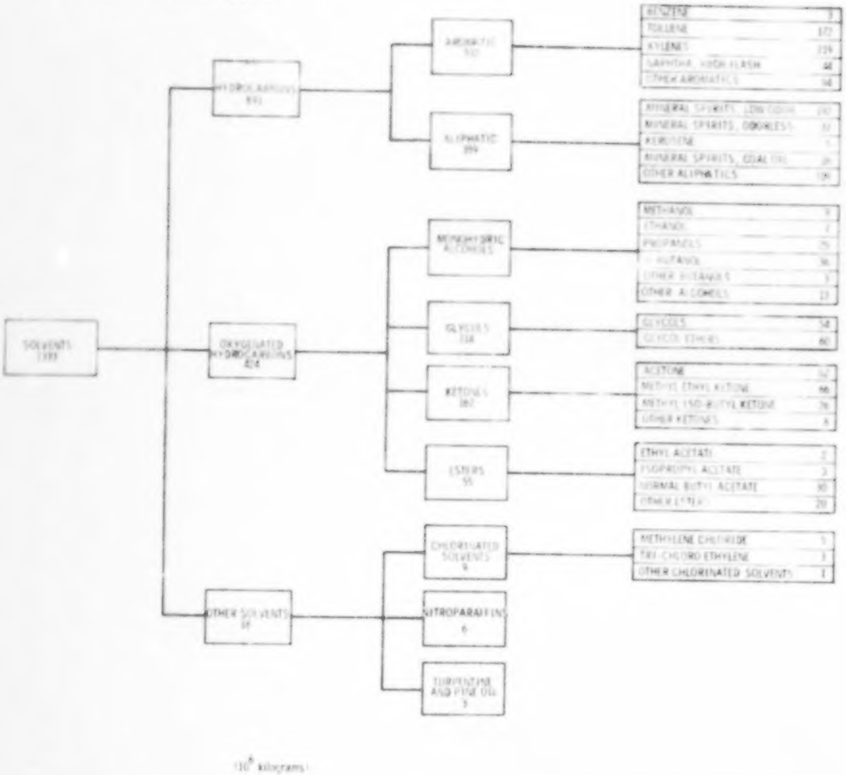
SOLVENTS
HYDROCARBONS
OXYGENATED HYDROCARBONS
OTHER SOLVENTS
AROMATIC
ALIPHATIC
MONOHYDRIC ALCOHOLS
GLYCOLS
KETONES
ESTERS 55
CHLORINATED SOLVENTS 9
NITROPARAFFINS 6
TURPENTINE AND PINE OIL 3
BENZENE
TOLUENE
XYLENES
NAPHTHA, HIGH FLASH
OTHER AROMATICS
MINERAL SPIRITS, LOW ODOR
MINERAL SPIRITS, ODORLESS
KEROSENE
MINERAL SPIRITS, COAL OIL
OTHER ALIPHATICS
METHANOL
ETHANOL
PROPANOLS
BUTANOL
OTHER BUTANOLS
OTHER ALCOHOLS
GLYCOLS 58
GLYCOL ETHERS 60
ACETONE
METHYL ETHYL KETONE
METHYL ISO-BUTYL KETONE
OTHER KETONES
ETHYL ACETATE 2
ISOPROPYL ACETATE 3
NORMAL BUTYL ACETATE 30
OTHER ESTERS 20
METHYLENE CHLORIDE 5
TRI-CHLORO ETHYLENE 3
OTHER CHLORINATED SOLVENTS 1
(10^6 kilograms)

Figure 16. Solvents used by the paints and allied products industry

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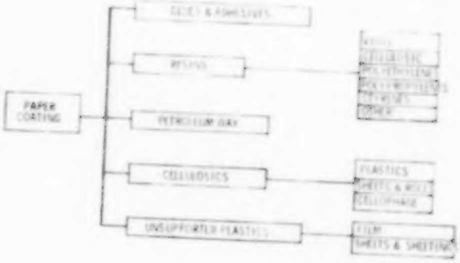
PAPER COATING
GLUES & ADHESIVES
RESINS
PETROLEUM WAX
CELLULOSICS
UNSUPPORTED PLASTICS
VINYL
CELLULOSIC
POLYETHYLENE
POLYPROPYLENES
STYRENES
OTHER
PLASTICS
SHEETS & ROLL
CELLOPHANE
FILM
SHEETS & SHEETING

Figure 17. Raw materials used in the paper and paperboard coating industry[60]

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[60] Preliminary Report, 1972 Census of Manufacturers, Paper Coating and Glazing, Standard Industrial Classification 2641, U.S. Department of Commerce, MC 72(P)-268-1, March, 1974.

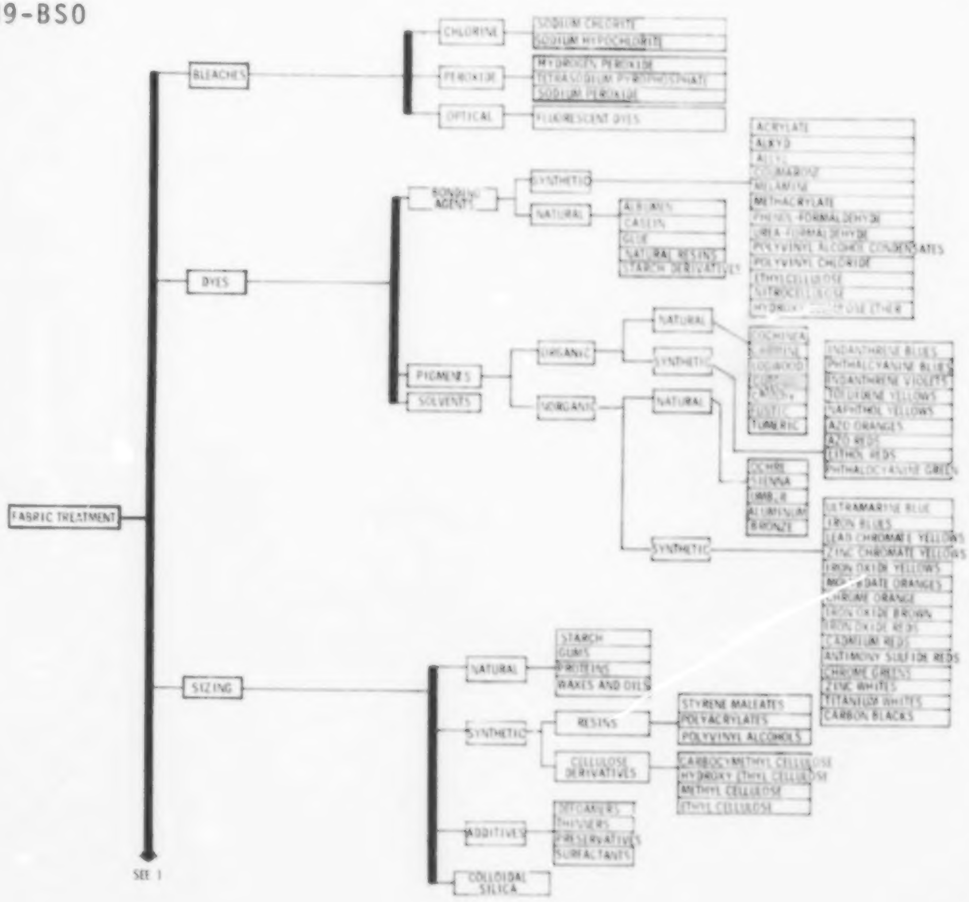
FABRIC TREATMENT
BLEACHES
CHLORINE
SODIUM CHLORITE
SODIUM HYPOCHLORITE
PEROXIDE
HYDROGEN PEROXIDE
TETRASODIUM PYROPHOSPHATE
SODIUM PEROXIDE
OPTICAL
FLUORESCENT DYES
DYES
BONDING AGENTS
SYNTHETIC
ACRYLATE
ALKYD
ALLYL
COUMARONE
MELAMINE
METHACRYLATE
PHENOL-FORMALDEHYDE
UREA-FORMALDEHYDE
POLYVINYL ALCOHOL CONDENSATES
POLYVINYL CHLORIDE
ETHYLCELLULOSE
NITROCELLULOSE
HYDROXY CELLULOSE ETHER
NATURAL
ALBUMEN
CASEIN
GLUE
NATURAL RESINS
STARCH DERIVATIVES
PIGMENTS
ORGANIC
NATURAL
COCHINEAL
CARMINE
LOGWOOD
FUSTIC
TUMERIC
SYNTHETIC
INDANTHRENE BLUES
PHTHALCYANINE BLUES
INDANTHRENE VIOLETS
TOLUIDENE YELLOWS
NAPHTHOL YELLOWS
AZO ORANGES
AZO REDS
LITHOL REDS
PHTHALOCYANINE GREEN
INORGANIC
NATURAL
OCHRE
SIENNA
UMBER
ALUMINUM
BRONZE
SYNTHETIC
ULTRAMARINE BLUE
IRON BLUES
LEAD CHROMATE YELLOWS
ZINC CHROMATE YELLOWS
IRON OXIDE YELLOWS
MOLYBDATE ORANGES
CHROME ORANGE
IRON OXIDE BROWN
IRON OXIDE REDS
CADMIUM REDS
ANTIMONY SULFIDE REDS
CHROME GREENS
ZINC WHITES
TITANIUM WHITES
CARBON BLACKS
SOLVENTS
SIZING
NATURAL
STARCH
GUMS
PROTEINS
WAXES AND OILS
SYNTHETIC
RESINS
STYRENE MALEATES
POLYACRYLATES
POLYVINYL ALCOHOLS
CELLULOSE DERIVATIVES
CARBOXYMETHYL CELLULOSE
HYDROXY ETHYL CELLULOSE
METHYL CELLULOSE
ETHYL CELLULOSE
ADDITIVES
DEFOAMERS
THINNERS
PRESERVATIVES
SURFACTANTS
COLLOIDAL SILICA
SEE 1

Figure 18. Raw materials flow diagram for the fabric treatment industry

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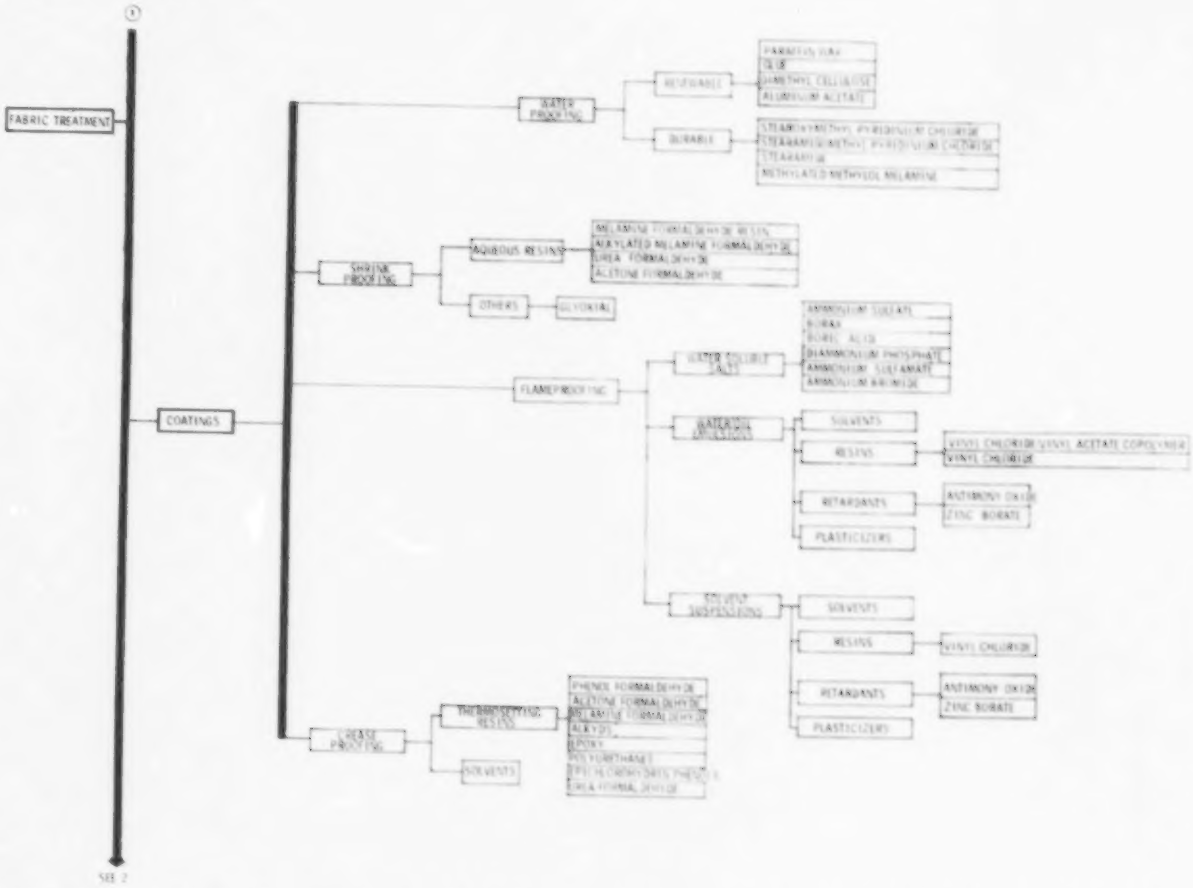

①
FABRIC TREATMENT
COATINGS
WATER PROOFING
REVERSIBLE
PARAFFIN WAX
GLUE
DIMETHYL CELLULOSE
ALUMINUM ACETATE
DURABLE
STEAROXYMETHYL PYRIDINIUM CHLORIDE
STEARAMIDOMETHYL PYRIDINIUM CHLORIDE
STEARAMIDE
METHYLATED METHYLOL MELAMINE
SHRINK PROOFING
AQUEOUS RESINS
MELAMINE FORMALDEHYDE RESIN
ALKYLATED MELAMINE FORMALDEHYDE
UREA FORMALDEHYDE
ACETONE FORMALDEHYDE
OTHERS
GLYOXAL
FLAMEPROOFING
WATER SOLUBLE SALTS
AMMONIUM SULFATE
BORAX
BORIC ACID
DIAMMONIUM PHOSPHATE
AMMONIUM SULFAMATE
AMMONIUM BROMIDE
WATER/OIL EMULSIONS
SOLVENTS
RESINS
VINYL CHLORIDE/VINYL ACETATE COPOLYMER
VINYL CHLORIDE
RETARDANTS
ANTIMONY OXIDE
ZINC BORATE
PLASTICIZERS
SOLVENT SUSPENSIONS
SOLVENTS
RESINS
VINYL CHLORIDE
RETARDANTS
ANTIMONY OXIDE
ZINC BORATE
PLASTICIZERS
CREASE PROOFING
THERMOSETTING RESINS
PHENOL FORMALDEHYDE
ACETONE FORMALDEHYDE
MELAMINE FORMALDEHYDE
ALKYDS
EPOXY
POLYURETHANES
EPICHLOROHYDRIN PHENOL
UREA FORMALDEHYDE
SOLVENTS
SH 2

Figure 18. (Cont.) Raw materials flow diagram for the fabric treatment industry

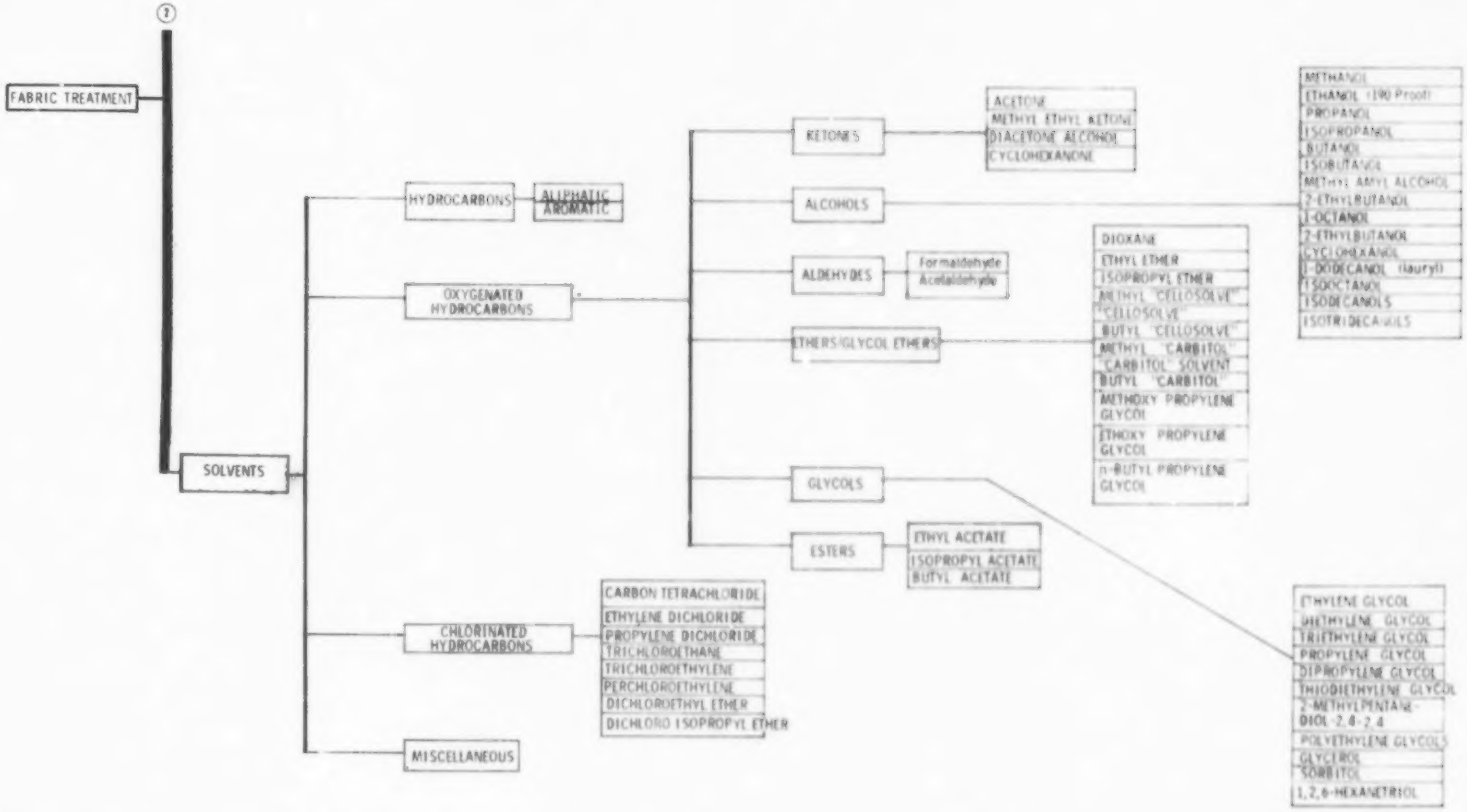
②
FABRIC TREATMENT
SOLVENTS
HYDROCARBONS
ALIPHATIC
AROMATIC
OXYGENATED HYDROCARBONS
CHLORINATED HYDROCARBONS
MISCELLANEOUS
KETONES
ALCOHOLS
ALDEHYDES
ETHERS/GLYCOL ETHERS
GLYCOLS
ESTERS
ACETONE
METHYL ETHYL KETONE
DIACETONE ALCOHOL
CYCLOHEXANONE
METHANOL
ETHANOL (190 Proof)
PROPANOL
ISOPROPANOL
BUTANOL
ISOBUTANOL
METHYL AMYL ALCOHOL
2-ETHYLBUTANOL
1-OCTANOL
2-ETHYLBUTANOL
CYCLOHEXANOL
1-DODECANOL (lauryl)
ISOOCTANOL
ISODECANOLS
ISOTRIDECANOLS
Formaldehyde
Acetaldehyde
DIOXANE
ETHYL ETHER
ISOPROPYL ETHER
METHYL "CELLOSOLVE"
"CELLOSOLVE"
BUTYL "CELLOSOLVE"
METHYL "CARBITOL"
"CARBITOL" SOLVENT
BUTYL "CARBITOL"
METHOXY PROPYLENE GLYCOL
ETHOXY PROPYLENE GLYCOL
n-BUTYL PROPYLENE GLYCOL
ETHYLENE GLYCOL
DIETHYLENE GLYCOL
TRIETHYLENE GLYCOL
PROPYLENE GLYCOL
DIPROPYLENE GLYCOL
THIODIETHYLENE GLYCOL
2-METHYLPENTANE-DIOL-2,4-2,4
POLYETHYLENE GLYCOLS
GLYCEROL
SORBITOL
1,2,6-HEXANETRIOL
ETHYL ACETATE
ISOPROPYL ACETATE
BUTYL ACETATE
CARBON TETRACHLORIDE
ETHYLENE DICHLORIDE
PROPYLENE DICHLORIDE
TRICHLOROETHANE
TRICHLOROETHYLENE
PERCHLOROETHYLENE
DICHLOROETHYL ETHER
DICHLORO ISOPROPYL ETHER

Figure 18. (Cont.) Raw materials flow diagram for the fabric treatment industry

SECTION IV

EMISSIONS

A. POLLUTANTS

The pollutants which were considered in this program were those from solvents and resins. The solvents considered were aliphatic and aromatic hydrocarbons, alcohols, glycols, glycol ethers, ketones, esters, chlorinated solvents, etc. The resins considered were acrylic resins, alkyds, epoxy resins, hydrocarbon resins, maleic resins, etc.

Other pollutants associated with industrial surface coating operations but which were not considered included pigments, additives, nitrogen oxides, sulfur oxides, carbon monoxide, etc. These materials were not included because the program objective was to develop a prioritization list based on emission of organic species only.

B. SELECTED POLLUTANTS

1. Composition of Emissions

Because of the number of different surface coating formulations, the emissions were broken down into 43 general formulations. The Paints and Allied Products industry contained 24 general formulations; these were obtained from the "Air Pollution Engineering Manual, AP-40."[4] The compositions of

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these surface coatings are presented in Table 18. The surface coatings used in the Paper and Paperboard Coating category were broken into 10 general formulations based on data from the patent literature. The surface coatings used in Fabric Treatment category were obtained from the patent literature and broken into 9 general formulations.

These formulations are presented in detail in Appendix A. For each surface coating formulation, the following are presented:

- Composition (solvent, resin, pigment)
- Assumed Coverage
- Emitted Species
- Emission Factors (solvents and resins)
- TLV of Forms Emitted

For the Paper and Paperboard coating and Fabric Treatment categories, the type of coating employed is given by type of application. However, for Paints and Allied Products, as many as eight different general surface coating formulations are used in a product-type category while as many as three different formulations are used for a product; e.g., dishwashers. Table 19 shows the breakdown of coatings used by product-type category and by product-type for Major Appliance Finishing.

In determining the emission factors for each product type, the surface coating formulations used for that product were weighted according to the amount of paint consumed by that product.

Table 18. EXAMPLES OF SURFACE COATING AND ADDED THINNER FORMULAS ON AN AS-PURCHASED BASIS HAVING CONFORMING SOLVENT SYSTEMS[4]

	Composition of surface coatings, % vol							
			Volatile portion					
Type of surface coating	Weight, kg/l	Nonvolatile portion	Aliphatic saturated	Aromatic	Alcohols saturated	Ketones	Esters saturated	Ethers saturated
Enamel, air dry	0.9	39.6	93.5	6.5				
Enamel, baking	1.1	42.8	82.1	11.7	6.2			
Enamel, dipping	1.2	59.0	58.2	7.2	30.9		3.7	
Acrylic enamel	1.1	30.3		6.9		80.6	12.5	
Alkyd enamel	1.0	47.2	92.5	7.5				
Primer surface	1.1	49.0	18.0	8.9	21.8	16.5	16.8	18.0
Primer, epoxy	1.3	57.2	44.8	15.9	3.0		28.8	7.5
Primer, zinc chromate	1.2	37.8	80.0	7.2	12.8			
Primer, vinyl zinc chromate	1.0	34.0	17.5	7.9		60.0		14.6
Epoxy-polyamide	1.3	34.7		19.9	26.4	34.5	19.2	
Varnish, baking	0.8	35.3				97.0		3.0
Lacquer, spraying	0.9	26.1	7.0	1.7	21.3	23.2	45.1	1.7
Lacquer, hot spray	1.0	16.5	16.4	6.8	24.3	17.2	14.8	20.5
Lacquer, acrylic	1.0	38.2	10.0	18.5	3.5	42.0	26.0	
Vinyl, roller coat	0.9	12.				43.5		56.5
Vinyl	1.1	22.00		18.9		81.1		
Vinyl acrylic	0.9	15.2				84.9	15.1	
Polyurethane	1.1	31.7		19.7		13.9	66.4	
Stain	0.9	2.6	80.6	14.0		0.1		5.3
Glaze	0.9	40.9	91.6	8.4				
Wash Coat	0.9	12.4	40.6	14.7	10.8	13.7	15.7	4.5
Sealer	0.8	11.7	41.2	7.0	14.7	19.1	18.0	
Toluene replacement thinner	0.8		55.5	17.5 (Toluene)			9.0	18.0
Xylene replacement thinner	0.8		56.5	7.5	24.0		12.0	

Table 19. SURFACE COATING FORMULATIONS FOR MAJOR APPLIANCE FINISHING[3]

	Coating type			
Major appliances	Acrylic enamel	Alkyd enamel	Cellulosic lacquer	Epoxy
Air conditioners	61.0%	39.0%	-	-
Dehumidifiers	61.0%	39.0%	-	-
Dishwashers	35.6%	22.8%	-	41.6%
Dryers	35.6%	22.8%	-	41.6%
Enameled plumbing fixtures	-	100.0%	-	-
Freezers	61.0%	39.0%	-	-
Furnaces	61.0%	39.0%	-	-
Humidifiers	35.6%	22.8%	-	41.6%
Lawn mowers	-	100.0%	-	-
Refrigerators	61.0%	39.0%	-	-
Stoves	-	100.0%	-	-
T.V.s and radios	-	-	100.0%	-
Trash compactors	-	100.0%	-	-
Washers	35.6%	22.8%	-	41.6%
Water heaters	35.6%	22.8%	-	41.6%
Water softeners	35.6%	22.8%	-	41.6%

2. Mass of Emissions

The mass of emissions from product-type surface coatings were obtained by multiplying the emission factors presented in Appendix A (g/m^2) by the unit surface area and by the number of units produced each year (1972).

$$Q = (F) \times (E) \times (K) \times (S) \qquad (1)$$

where:

Q = Mass of emissions (kg/year)

S = Unit surface area (m^2/unit)

K = Number of units produced (units/year)

E = Emission factor (g/m^2)

F = Conversion factor (0.001 kg/g)

The National Paint and Coatings Association (NPCA)[61] has estimated the total mass of emissions from all Paint and Allied Products. These data are presented in Table 20.

3. Threshold Limit Values of Species Emitted

The Threshold Limit Values (TLV®) for various organic and inorganic chemicals are presented in "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1973."[62] This copyrighted document was published by the American Conference of Governmental Industrial Hygienists.

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[61] Data supplied by the National Paint and Coatings Association.

[62] Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1973, American Conference of Governmental Industrial Hygienists, 1972.

Table 20. SOLVENT AND RESIN EMISSIONS FROM PAINT AND ALLIED PRODUCTS[61]

Species emitted	1972 Emissions, 10^6 kg
Solvent phase resins	
Acrylic solution-resins-lacquer	2.3
Acrylic solution-resins-thermosetting	9.9
Alkyds	40.5
Epoxy resins	12.5
Epoxy ester resins	1.6
Hydrocarbon resins	0.9
Maleic resins	0.3
Phenolic resins, pure	1.8
Polyurethane resins	3.3
Silicone resins	0.6
Urea & melamine formaldehyde resins	6.3
Vinyl (formal & butyral) acetal resins	1.0
Vinyl acetate solution-type copolymer resins	2.2
Vinyl chloride copolymer resins	6.0
Other solvent-phase resins	3.3
Aluminum pastes	1.7
Sub-total	94.2
Aliphatic hydrocarbon solvents	
Mineral spirits, low odor	192.0
Mineral spirits, odorless	36.9
Kerosene	5.1
Mineral spirits, coal oil	15.8
Others	109.0
Sub-total	358.8

Table 20. (Cont.) SOLVENT AND RESIN EMISSIONS FROM PAINT AND ALLIED PRODUCTS[61]

Species emitted	1972 Emissions, 10^6 kg
Aromatic and naphthenic hydrocarbons	
Benzene	3.2
Toluene	173.0
Xylenes	218.0
Naphtha, high flash	44.2
Others	94.4
	Sub-total 532.8
Terpenic hydrocarbons	3.2
Monohydric alcohols	
Methanol	8.7
Ethanol (all denatured grades)	6.9
Propanol (normal and iso)	25.3
n-Butanol	36.2
Other butanols	3.2
Others	12.8
	Sub-total 93.1
Glycols and derivatives	
Glycols	54.4
Glycol ethers	60.0
	Sub-total 114.4
Ketones	
Acetone	61.4
Methyl ethyl ketone	66.0
Methyl isobutyl ketone	26.3
Others	7.8
	Sub-total 161.5

Table 20. (Cont.) SOLVENT AND RESIN EMISSIONS FROM PAINT AND ALLIED PRODUCTS[61]

Species emitted		1972 Emissions, 10^6 kg
Esters		
Ethyl acetate		2.8
Isopropyl acetate		2.7
Normal butyl acetate		29.8
Others		19.6
	Sub-total	54.9
Chlorinated solvents		
Methylene chloride		4.6
Trichloroethylene		3.3
Others		0.8
	Sub-total	8.7
Other solvents and dilutents		26.6
	Total	1448.2

This document does not list TLV's for solvent mixtures. It does, however, present a method of calculating a composite TLV for total evaporative solvent mixtures. This formula is:

$$\mathrm{TLV}_{\mathrm{composite}} = \frac{1}{\frac{f_a}{\mathrm{TLV}_a} + \frac{f_b}{\mathrm{TLV}_b} + \ldots + \frac{f_m}{\mathrm{TLV}_m}} \qquad (2)$$

where TLV values, in $\mathrm{mg/m^3}$, and f values, in weight fraction, are inserted for each individual component a, b, . . . m of the mixture.

This formula was used to calculate the composite TLV's for the following constituents of solvent mixtures:

- Aliphatic and aromatic hydrocarbons
- Monohydric alcohols
- Ketones
- Esters
- Ethers and glycols

The total mass of emissions data from NPCA was used to calculate the composite TLV's for the above solvent mixtures. An example calculation is presented below and all composite TLV's for the solvent mixtures are summarized below.

The following data on aromatic hydrocarbons are known:[61]

Species emitted	NPCA emission rate, 10^6 kg/yr	Weight fraction	TLV, mg/m^3
Benzene	3.2	0.006	80
Toluene	173.0	0.325	375
Xylenes	218.0	0.409	435
Naphtha, high flash	44.2	0.083	400
Other naphthenic[a] compounds	94.4	0.177	1050
Totals	532.8	1.000	

[a] TLV for cyclohexane

The above data were substituted in Eq. 2:

$$\text{TLV}_{\text{aromatics}} = \frac{1}{\frac{0.006}{80} + \frac{0.325}{375} + \frac{0.409}{435} + \frac{0.083}{400} + \frac{0.177}{1050}}$$

$$= 442.9 \text{ mg/m}^3$$

For this program, it was assumed that this mixture is as hazardous as toluene because the above composite TLV assumes that all aromatic hydrocarbons have exactly the same composition. The TLV for toluene was chosen to represent a worst case analysis:

$$\text{TLV}_{\text{aromatics}} \equiv 375 \text{ mg/m}^3$$

Summary of Solvent Mixture TLV's

Solvent Mixture	Composite TLV, mg/m^3
Aliphatic hydrocarbons	2800
Aromatic hydrocarbons	375
Monohydric alcohols	500
Ketones	590
Esters	710
Ethers and glycols	120

The TLV's used for the resin species were those of the resin itself. For example, the TLV used for vinyl chloride is 2.6 mg/m^3 and this is the TLV which was used for vinyl resin emissions.

C. LOCATIONS AND DESCRIPTION

Figure 19 is a schematic flow diagram of a surface coating operation. This diagram shows the operations, auxiliary facilities, and emission points. The operations shown include degreasing, surface coating, and drying and curing. Auxiliary facilities include degreasing solvent storage, surface coating raw materials storage and blending, air compression, and steam generation.

A brief process description is presented below to show where emission points occur in the process. In this description, three specific examples are given: (1) sheet, strip, and

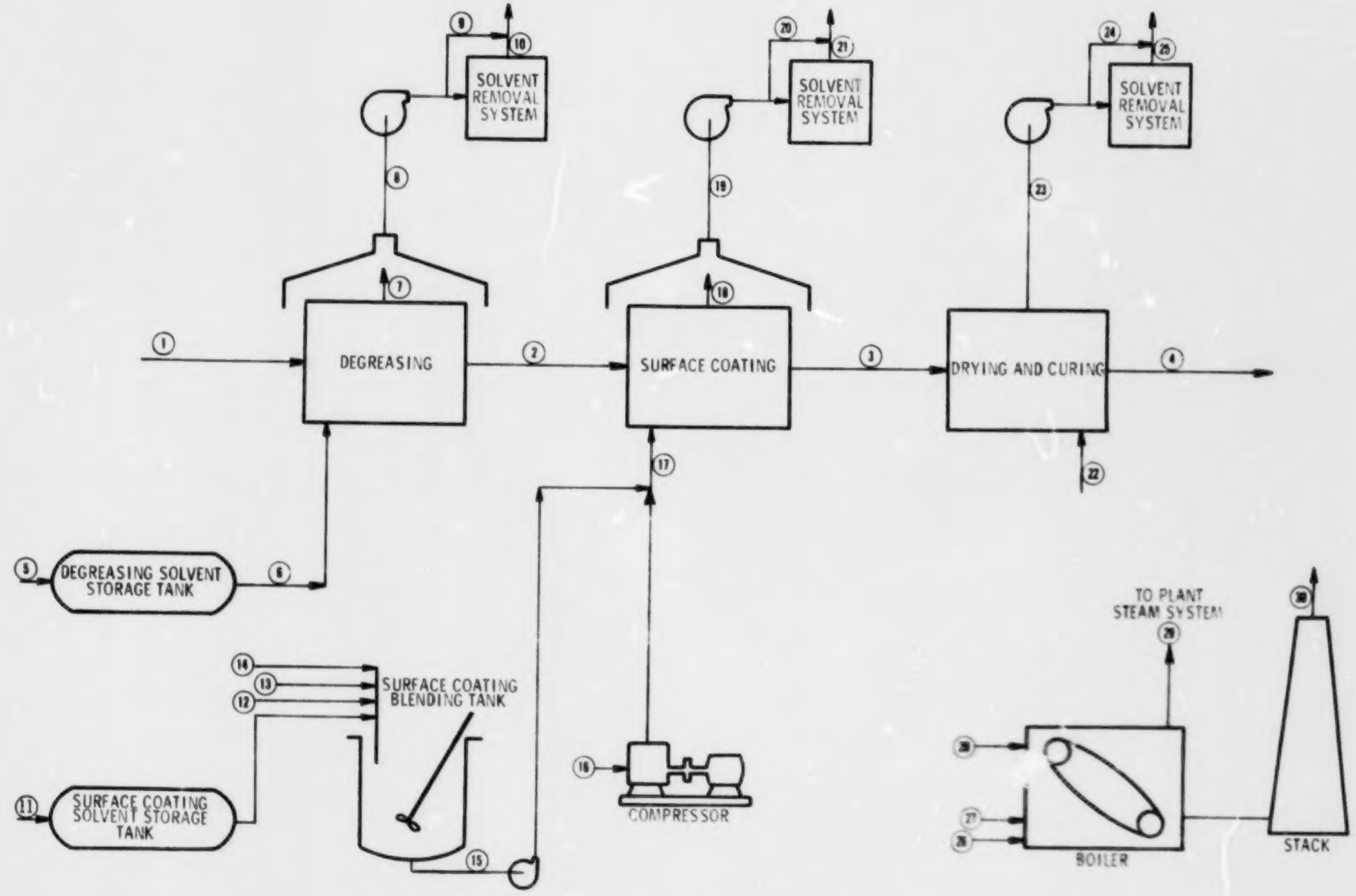
SOLVENT REMOVAL SYSTEM
SOLVENT REMOVAL SYSTEM
SOLVENT REMOVAL SYSTEM
DEGREASING
SURFACE COATING
DRYING AND CURING
DEGREASING SOLVENT STORAGE TANK
SURFACE COATING BLENDING TANK
SURFACE COATING SOLVENT STORAGE TANK
COMPRESSOR
TO PLANT STEAM SYSTEM
BOILER
STACK
1
2
3
4
5
6
7
8
9
10
11
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Figure 19. Flow diagram of a surface coating operation

coil coating; (2) paper and paperboard coating; and (3) fabric treatment. These examples were chosen because together they account for 95% of the total mass of emissions from surface coating operations.

1. Product Flow

In Figure 19, streams 1, 2, 3, and 4 depict the flow of products through the plant. Stream 1 represents the input of uncoated products to the surface coating system. For sheet, strip, and coil coating and for fabric treatment, the product is degreased or scoured using halogenated hydrocarbons. Paper and paperboard are not degreased prior to surface coating since these are not lubricated for machining and handling purposes as are the other product types.

Stream 2 represents the flow of degreased or scoured products to the surface coating operation. The type of surface coating operation used depends upon the product-type coated, coating requirements, and the method of application. Details of the types of surface coating operations are presented in Section 3 of this report.

Stream 3 represents the product flow to the drying and curing operation. The types of equipment used in this operation are detailed in Section 3. The drying and curing methods used for the three examples given are summarized below.

Product-type category	Drying and curing methods
Sheet, strip, and coil coating	Bake ovens
Paper and paperboard coating	Direct contact drying; evaporative drying
Fabric treatment	Direct contact drying

Stream 4 represents the flow of coated finished products from the surface coating section of a manufacturing plant.

2. Degreasing

In Figure 19, streams 5 through 10 represent the flow of degreasing solvent through the surface coating section of a manufacturing plant. Streams 5 and 6 depict the flow of solvent into the plant and to the degreasing unit, respectively. Streams 7 and 8 represent the flow of solvent vapors from the degreasing unit through the fume handling system. Uncontrolled and controlled emissions are represented by streams 9 and 10, respectively.

3. Surface Coating

In Figure 19, streams 11 through 21 represent the flow of surface coating raw materials through the plant. Streams 11, 12, 13, and 14 represent the flow of solvent, pigment, resin, and additives to the surface coating blending tank. Stream 15 is the flow of coating to the surface coating unit. For those operations that use spray painting, stream 16 is the flow of compressed air. Streams 18 and 19 represent the flow of solvent and resins from the surface coating unit through the fume handling equipment. Uncontrolled and controlled emissions are depicted by streams 20 and 21, respectively.

4. Drying and Curing

In Figure 19, streams 22 through 25 represent the flow of gases through the drying and curing system. Stream 22 represents the flow of either fuel, steam, or electrically heated air to the drying and curing operation for forced evaporative drying and air for free evaporative drying. Stream 23 is the flow of gases from the drying area. Streams 24 and 25 represent uncontrolled and controlled emissions.

5. Steam Generation

Streams 26 through 30 represent the flow of materials through the steam generation system. Streams 26 and 27 represent the flow of fuel and combustion air to the boiler. Stream 28 is boiler feed water and stream 29 is the steam produced. Stream 30 represents the flow of combustion gases from the steam generation system.

6. Emission Points

There are two types of emissions from surface coatings plant operations: point source emissions, and fugitive emissions.

The point source emissions include the controlled and uncontrolled emissions from the degreasing, surface coating, and drying and curing operations. Other point sources include the degreasing solvent storage tank vent, surface coating solvent vent, surface coating blending tank vent, and the steam generation stack.

The fugitive emission sources include solvent evaporation losses from degreased, coated, and dried products (Streams 2, 3, and 4). They also include losses from each piece of processing equipment and from the transfer of organic liquids within the plant.

D. CURRENT EMISSIONS LEGISLATION

Currently, emissions control is dictated by Los Angeles Rule 66-type[4] legislation which has been instituted by a total of 20 states and local legislatures. These are: Alabama, Arizona, California (county regulations), Colorado, Connecticut, District of Columbia, Florida, Illinois, Indiana, Kentucky, Louisiana, Maryland, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Virginia, Wisconsin and Puerto Rico.[63]

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[63] Pollution Control Guide, Commerce Clearing House, Inc., Paragraph 4951, page 4999-5, August 26, 1974.

SECTION V

PRIORITIZATION OF SOLVENT EMISSION SOURCES

A. IMPACT FACTOR CALCULATION

1. Method of Calculation

The prioritization model used in this program is the prioritization model developed under the Source Assessment Program.[64] The relative priority for a given source type has been defined as follows:

$$I_x = \left\{ \sum_{j=1}^{K} Pj \left\{ \sum_{i=1}^{N} \left[\left(\frac{\bar{\chi} i_j}{F_i} \right)^2 \left(\frac{\chi' i_j}{S_i} \right) \right] \right\} \right\}^{1/2} \qquad (1)$$

where I_x = impact factor (persons/km^2)

P_j = population density in the defined region or affected area (persons/km^2)

$\chi' i_j$ = annual mean concentration of the ith criteria pollutant in the jth region (g/m^3)

S_i = corresponding standard for the ith criteria pollutant (g/m^3)

N = number of hazardous materials emitted by each source

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[64] Anon., Prioritization of Sources of Air Pollution, Monsanto Research Corp., EPA Contract 68-02-1320, 31 July 1974.

F_i = hazard potential factor (g/m^3)

$\bar{\chi}_{i_j}$ = calculated maximum ground level concentration of the ith material emitted by a source in the jth region (g/m^3)

K = number of sources of a given type

The relative hazard factor was defined as follows:

$$F = TLV \times 40/168 \times 1/100 \qquad (2)$$

where TLV is the threshold limit value (g/m^3). Threshold Limit Values correspond to time-weighted concentrations for a 40-hour workweek. Since the local population is exposed to the emissions all week long and not just during working hours, the TLV has been decreased by a factor of 40/168. Also, since the effects of species accumulation within the body and possible synergism with other emitted species are unknown, a safety factor of 100 was also used.

The emission rate of a specific material was computed from the capacity times the appropriate emission factor divided by the frequency of that emission. Since we sought to establish a worst-case condition, the maximum ground level concentration was computed. For an elevated point source, in neutral conditions, atmospheric stability class C, the following equation is applicable:

$$\chi_{max} = \frac{2Q}{\pi H^2 e \bar{u}} \qquad (3)$$

where Q = emission rate (g/sec)

$\bar{u}$ = average wind speed (m/sec) = 4.47 m/sec

H = effective emission height (m)

e = 2.72

The factor X'/S was used only for the criteria pollutants. It was set equal to 1 for all other emitted materials. For a given source type, we sought to (a) identify the hazardous materials being emitted, (b) estimate their emission rates, (c) determine their hazard potential factor, (d) determine the ambient air levels of criteria pollutants if they are being emitted by a specific type of source, (e) estimate the heights of emissions, and (f) estimate the number of people affected by each source in a given area.

The impact factor obtained from the model is an integral quantity with no absolute value. It is, however, a relative measure of the health hazard to the local population when they are exposed to the maximum concentration of all species emitted.

This model, and one modification of it, was used to generate four priority lists. The four priority lists have been identified as Options 1, 2, 3, and 4.

Option 1

Option 1 used the model precisely as it has been presented above. (Toxicity Priority List)

Option 2

Option 2 used the model as it has been presented above except that the TLV used for all emitted organic species was the TLV for photochemical oxidants. This value has been defined as $TLV_{ox} = 0.0672\ g/m^3$ under the Source Assessment Program. (Oxidants Priority List)

Option 3

Option 3 used the model as it has been presented above except that the TLV used was whichever was lower: the emitted species TLV or TLV_{ox}. (Worst Case)

Option 4

Option 4 used a modified version of the impact factor. Instead of developing a list of priorities based on the Impact Factor, the priority list was based on yearly total mass of emissions of organic materials. (Mass of Hydrocarbon Emissions)

2. Priority Lists

Information for the prioritization model has been gathered from various sources. These sources include:

- U.S. Department of Commerce; 1972 Census of Manufactures
- Thomas Register of American Manufacturers
- National Paint and Coatings Association
- Chemical Economics Handbook
- American Conference of Governmental Industrial Hygienists
- Others (see References)

The information sought includes source description, source identification (location and capacity), state population densities, statistics on quantities and types of emissions, and Threshold Limit Values of potentially hazardous emissions.

Appendix B contains the data used to determine the priority lists for those products which comprise the 25 largest product-type emitters as determined on a total mass of emissions basis (Option 4).

The degree of uncertainty for the collected data varies from product type to product type depending on the nature and amount of information available. Recognizing this difficulty, confidence levels of A through D have been developed. The priority index confidence levels are summarized below.

Confidence level	Description
A	Priority index given is within 10% of the true value; this number is obtained only through extensive sampling.
B	Priority index given is within 50% of the true value.
C	Priority index given is within 100% of the true value.
D	Priority index given is of indeterminate quality.

The confidence levels are presented as a means of summarizing our overall appraisal of the reliability of the data gathered for each product type. All of the product types have been assigned a confidence level of either B or C.

The overall priority lists for each of the four options considered are presented in Tables 21, 22, 23, and 24. Individual priority lists for product-type by product-type category for each of the four options are given in Appendix C.

Table 21. EVAPORATION FROM SURFACE COATINGS: OPTION 1
(Toxicity Priority List)

RANK	SOURCE TYPE	IMPACT FACTOR	CL	CAT
1	DYEING	900,000	C	10
2	METAL CANS - EXCLUDING BEVERAGE CANS	900,000	E	7
3	PAPER BAGS	500,000	B	9
4	BEVERAGE CANS	500,000	B	7
5	COATED PAPER - EXCLUDING WAXED	400,000	B	9
6	KRAFT PAPER	300,000	B	9
7	PRINTING PAPER	200,000	B	9
8	DUCTWORK	200,000	C	7
9	MILK CARTON BOARD	100,000	B	9
10	OILED AND WAXED PAPER	90,000	B	9
11	PAPER BOXES	90,000	B	9
12	WOOD PANELING	80,000	C	7
13	CANOPIES AND AWNINGS	40,000	C	7
14	SIZING	30,000	C	10
15	FOLDING CARTONS	30,000	B	9
16	FENCING	20,000	B	7
17	SCREENING	20,000	B	7
18	REFRIGERATORS	10,000	B	1
19	FILING CABINETS	10,000	B	8
20	ENAMELED PLUMBING FIXTURES	9,000	B	1
21	PUMPS	9,000	B	4
22	BEDROOM FURNITURE	9,000	B	6
23	PAPER CANS, TUBES, DRUMS	8,000	B	9
24	TABLES	8,000	B	6
25	METAL DOORS - EXCLUDING GARAGE DOORS	8,000	B	7
26	SPINNING FRAMES	8,000	B	4
27	GUTTERS	7,000	B	7
28	CABINETS	7,000	B	6
29	DESKS	7,000	B	8
30	BEER AND SOFT DRINK BOTTLE CAPS	6,000	B	7
31	RADIOS AND TELEVISIONS	6,000	B	1
32	COMPRESSORS	6,000	B	4
33	DRYERS	5,000	B	1
34	TABLES	5,000	B	8
35	WASHERS	5,000	B	1
36	STOVES	5,000	B	1
37	CHAIRS	5,000	B	8
38	VENDING MACHINES	5,000	B	5
39	TWISTING FRAMES	4,000	B	4
40	FREEZERS	4,000	B	1
41	ALUMINUM SIDING AND ROOFING	4,000	B	7
42	WRINKLE RESISTANT FINISHES	4,000	C	10
43	ELECTRIC FANS	4,000	B	2
44	WATER HEATERS	4,000	B	1
45	CHAIRS	3,000	B	6
46	GARAGE DOORS	2,000	B	7
47	AIR CONDITIONERS	2,000	B	1
48	COAT RACKS	2,000	C	8
49	DOOR AND WINDOW FRAMES	2,000	B	7
50	AUTOMOTIVE MAINTENANCE EQUIPMENT	2,000	C	4
51	FURNACES	2,000	B	1
52	ROTARY DRILLING EQUIPMENT - SUBSURFACE	2,000	B	4
53	TYPEWRITERS	2,000	B	5
54	DISHWASHERS	2,000	B	1
55	BOXES AND RACKS	1,000	B	3
56	LAMPS	1,000	B	2

Table 21 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 1
(Toxicity Priority List)

57	SAFES AND VAULTS	1,000	B	8
58	SAWING MACHINES - WOOD	1,000	B	4
59	DESKS	1,000	B	6
60	CABINETS	1,000	C	8
61	CARPET CARE APPLIANCES	1,000	B	2
62	PERMANENT CRISPNESS	1,000	C	10
63	FARM WAGONS	1,000	B	3
64	RAILINGS, FIRE ESCAPES, STAIRCASES	1,000	B	7
65	LAWN MOWERS	800	B	1
66	MAILING AND PARCEL POST SCALES	800	B	5
67	BLEACHING, DRYING, FINISHING MACHINERY	700	C	4
68	PACKING, PACKAGING, BOTTLING MACHINERY	700	B	4
69	REBUILT PULP AND PAPERMILL MACHINERY	600	C	4
70	FARM ELEVATORS - PORTABLE	600	B	3
71	HAND SPRAYERS	600	B	3
72	WASTE CANS	600	C	8
73	GRINDING AND POLISHING MACHINES	600	B	4
74	CHOPPERS, GRINDERS, CUTTERS, ETC. - FOOD	500	B	4
75	TRACTORS	500	B	3
76	PHONOGRAPHS	500	B	2
77	DUPLICATING MACHINES	500	B	5
78	HUMIDIFIERS	500	B	1
79	SEWING MACHINES	500	B	2
80	BATHROOM SCALES	500	B	2
81	COFFEE POTS	400	B	2
82	LATHES, PLANERS, ETC. - WOOD	400	C	4
83	PRESSES - METAL	400	B	4
84	ELECTRIC TOOLS	400	B	2
85	POULTRY FEEDERS	400	C	3
86	BOOKCASES	400	B	6
87	COMBINES	400	B	3
88	INDUSTRIAL WATER SOFTENERS	400	B	5
89	WELDING AND CUTTING APPARATUS	300	C	4
90	INDUSTRIAL TRUCKS	300	B	4
91	DEHUMIDIFIERS	300	B	1
92	PROJECTORS - MOVIE AND SLIDE	300	B	2
93	PUNCHING AND SHEARING MACHINES	300	B	4
94	ELECTRIC COOKWARE	300	B	2
95	MIXERS	300	B	2
96	BLENDERS	200	B	2
97	DRILLING MACHINES	200	B	4
98	BENDING AND FORMING MACHINES	200	B	4
99	GASOLINE PUMPS	200	B	5
100	MAILING MACHINES	200	B	5
101	FLOWING WELL EQUIPMENT	200	C	4
102	CHEMICAL MANUFACTURING INDUSTRIAL MACH	200	C	4
103	STACK SHREDDERS	200	B	3
104	WOOD PREPARATION EQUIPMENT - PULPMILLS	200	C	4
105	FORAGE BLOWERS	200	B	3
106	SPACE HEATERS	200	B	2
107	METAL CLEANING MACHINERY	200	C	4
108	FRUIT AND VEGETABLE CANNING MACHINERY	200	C	4
109	MEAT AND POULTRY PROCESSING MACHINERY	200	C	4
110	KNITTING MACHINES	200	B	4
111	CEMENT MAKING MACHINERY	200	C	4
112	SHELVING	200	C	7
113	HOG FEEDING EQUIPMENT	200	B	3
114	GARBAGE DISPOSALS	200	B	2
115	IRONS	100	B	2
116	TRASH COMPACTORS	100	B	1

Table 21 (Cont.) EVAPORATION FROM SURFACE COATING: OPTION 1
(Toxicity Priority List)

117	LATHES - METAL	100	B	4
118	NESTS AND CAGES	100	B	3
119	CHAIN SAWS	100	B	4
120	TURKEY FEEDERS	100	B	3
121	JOINTERS	100	C	4
122	PAPER AND PAPERBOARD CONVERTING MACHINER	100	B	4
123	PLASTICS WORKING MACHINERY	100	B	4
124	HOISTS	100	B	4
125	CAMERAS	100	B	2
126	WATER SOFTENERS	100	B	1
127	ADDING MACHINES	100	B	5
128	SNOW BLOWERS	100	B	2
129	TIME RECORDERS	100	B	5
130	MOTOR TRUCK SCALES	100	B	5
131	WIRE PRODUCTS	100	C	7
132	FORMS HANDLING EQUIPMENT	100	B	5
133	COMMERCIAL DISHWASHERS	90	B	5
134	ROD LIFTING MACHINERY - OIL	90	C	4
135	BROODERS	90	B	3
136	CHECK HANDLING MACHINES	80	B	5
137	COTTON GINNING MACHINERY	80	C	4
138	MINE CARS, TRACK	80	B	4
139	SUGAR PLANT PROCESSING MACHINERY	80	C	4
140	BOOK CASES	80	B	8
141	MANURE SPREADERS	80	B	3
142	BALE THROWING ATTACHMENTS	80	B	3
143	BROADCAST SEEDERS	70	B	3
144	DAIRY MACHINES	70	B	3
145	MILLING MACHINES	70	B	4
146	FERTILIZER DISTRIBUTORS	70	B	3
147	TOASTERS	60	C	2
148	HAND DUSTERS	60	B	3
149	TYPESETTING MACHINERY	60	B	4
150	YARN PREPARING MACHINES	60	B	4
151	SAWMILL EQUIPMENT	60	C	4
152	CASH REGISTERS	60	C	5
153	TOBACCO MANUFACTURING MACHINES	50	B	4
154	OTHER SPRAYERS - NON-TRACTOR	50	B	3
155	SCREENS - MINING	50	B	4
156	FIELD FORAGE HARVESTORS	50	B	3
157	ELECTRIC RAZORS	50	B	2
158	STEEL SHIPPING BARRELS	50	B	7
159	CLAYWORKING MACHINER	50	C	4
160	DICTATING MACHINES	50	B	5
161	OFF-SET LITHOGRAPHIC PRESSES	50	B	4
162	DRYERS	50	B	3
163	WATER PROOF AND WATER REPELLENT FINISHES	50	C	10
164	PAPERMILL MACHINERY	50	B	4
165	ACCOUNTING MACHINES	40	C	5
166	CONSTRUCTION CRANES	40	B	4
167	FOGGERS AND MIST SPRAYERS	40	B	3
168	SAWING AND CUTOFF MACHINES - METAL	40	B	4
169	FEEDERS	40	B	4
170	CLEANING AND OPENING MACHINES	40	B	4
171	POWER SPRAYERS	40	B	3
172	OVERHEAD CRANES	40	B	4
173	SHOEMAKING MACHINERY	40	C	4
174	MOTORIZED HAND TRUCKS	40	B	4
175	ROTARY CULTIVATORS	40	B	3
176	CRUSHERS	30	B	4

Table 21 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 1
(Toxicity Priority List)

177	ICE CREAM FREEZERS	30	C	4
178	HOG WATERING EQUIPMENT	30	B	3
179	BLADE TERRACERS	30	B	3
180	TAPE RECORDERS	30	C	2
181	MOWER-CONDITIONERS	30	B	3
182	INCUBATORS	30	B	3
183	EXCAVATORS	30	B	4
184	PEANUT COMBINES	30	B	3
185	PLANERS - METAL	30	C	4
186	COMMERCIAL FLOOR WAXERS	30	B	5
187	HOT ROLLING MILL MACHINES	30	C	4
188	FARM ELEVATORS - STATIONARY	20	B	3
189	CONCRETE PRODUCT MACHINERY	20	B	4
190	MOWERS	20	B	3
191	HAIR DRYERS	20	C	2
192	CAN OPENERS AND KNIFE SHARPENERS	20	B	2
193	SHUTTLE CARS - MINING	20	B	4
194	RETAIL AND COMMERCIAL SCALES	20	B	5
195	FEED GRINDERS	20	B	3
196	HAY BALERS	20	B	3
197	FLOUR AND GRAIN MILL MACHINERY	20	C	4
198	HARROWS	20	B	3
199	COLD ROLLING MILL MACHINES	20	C	4
200	HAY CONDITIONERS	20	B	3
201	FLOTATION MACHINES	20	B	4
202	GLASS MAKING MACHINERY	20	B	4
203	CORN AND COTTON CULTIVATORS	20	B	3
204	MOLDBOARD PLOWS	10	B	5
205	GEAR CUTTING MACHINES	10	B	4
206	CLASSIFIERS	10	B	4
207	LETTERSET PRINTING PRESSES	10	B	4
208	BINDERY EQUIPMENT	10	B	4
209	LOADING, CUTTING, LONGWALL MINING MACH	10	B	4
210	FIELD CULTIVATORS	10	B	3
211	AIR-CARRIED TYPE POWER SPRAYER	10	B	3
212	DRILLS - MINING	10	B	4
213	WINDROWERS - HAY	10	B	3
214	FOUNDRY MACHINERY	10	C	4
215	VENEER AND PLYWOOD EQUIPMENT	10	C	4
216	PULPMILL MACHINERY	10	B	4
217	CARDING AND COMBING MACHINES	10	B	4
218	HAY STACKING ATTACHMENTS	10	B	3
219	CORN SHELLERS	10	C	3
220	ELECTRONIC TUBE MANUFACTURING MACHINERY	9	C	4
221	COMMERCIAL CARPET SWEEPERS	9	B	5
222	CORN PICKERS	8	B	3
223	GRINDING MILLS	8	B	4
224	MAGNETIC SEPARATORS	7	B	4
225	HOMOGENIZERS AND PASTEURIZERS	7	B	4
226	CENTRIFUGAL DRIERS	7	B	4
227	CONCRETE MIXERS	7	B	4
228	CORN PLNTRS, LISTERS, POTATO PLNTRS, TRN	6	B	3
229	BAKERY MACHINERY	6	B	4
230	FRONT AND REAR MOUNTED LOADERS	5	B	3
231	PEANUT DIGGERS	5	B	3
232	TAPPING MACHINES	5	B	4
233	BORING MACHINES	5	B	4
234	CONTINUOUS MINING MACHINES	5	B	4
235	BUTTER AND CHEESE PROCESSING MACHINERY	4	B	4
236	ELECTRONIC CALCULATORS	4	B	5

Table 21 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 1
(Toxicity Priority List)

237	WET CYCLONES - MINING	4	B	4
238	HAY BALE LOADERS	3	B	3
239	MANURE PUMPS	3	B	3
240	RAKES	3	B	3
241	COTTON STRIPPERS	2	B	3
242	SCRUBBERS - MINING	2	B	4
243	GRAIN DRILLS	2	C	3
244	FEED MIXERS	2	B	3
245	POWER DUSTERS	2	B	3
246	GRAVURE PRINTING PRESSES	2	B	4
247	SUBSOILERS - DEEP TILLAGE	2	B	3
248	MIDDLEBUSTERS AND DISC BEDDERS	2	B	3
249	THERMAL DRIERS - MINING	2	B	4
250	BEET HARVESTORS	1	B	3
251	CHISEL PLOWS	1	B	3
252	CONCENTRATING TABLES	1	B	4
253	TERRACING AND DITCHING PLOWS	1	B	3
254	TOBACCO CURERS	1	B	3
255	POTATO HARVESTORS	1	B	3
256	LAND LEVELERS	1	B	3
257	WINDROWERS OR SWATHERS	1	B	3
258	FLEXOGRAPHIC PRINTING PRESSES	1	B	4
259	TURKEY WATERERS	1	C	3
260	BROACHING MACHINES	1	B	4
261	ROTARY DRILLING EQUIPMENT - SURFACE	1	B	4
262	WASHING AND STERILIZING EQUIPMENT	1	C	4
263	ROD WEEDERS	1	B	3
264	SHAPERS - METAL	1	B	4
265	BEET, BEAN, AND VEGETABLE CULTIVATORS	1	B	3
266	DISC PLOWS	1	B	3
267	EGG WASHERS	1	B	3
268	EGG GRADERS	1	B	3

Table 22. EVAPORATION FROM SURFACE COATINGS: OPTION 2
(Oxidants Priority List)

RANK	SOURCE TYPE	IMPACT FACTOR	CL	CAT
1	COATED PAPER - EXCLUDING WAXED	10,000,000	B	9
2	PRINTING PAPER	6,000,000	B	9
3	PAPER BOXES	2,000,000	B	9
4	MILK CARTON BOARD	2,000,000	B	9
5	OILED AND WAXED PAPER	1,000,000	B	9
6	SIZING	1,000,000	C	10
7	METAL CANS - EXCLUDING BEVERAGE CANS	900,000	B	7
8	FOLDING CARTONS	700,000	B	9
9	BEVERAGE CANS	500,000	B	7
10	PAPER CANS, TUBES, DRUMS	200,000	B	9
11	DUCTWORK	200,000	C	7
12	WOOD PANELING	100,000	C	7
13	DYEING	90,000	C	10
14	PAPER BAGS	80,000	B	9
15	WRINKLE RESISTANT FINISHES	70,000	C	10
16	KRAFT PAPER	50,000	B	9
17	SCREENING	40,000	B	7
18	CANOPIES AND AWNINGS	40,000	C	7
19	FENCING	20,000	B	7
20	WATER PROOF AND WATER REPELLENT FINISHES	20,000	C	10
21	BEER AND SOFT DRINK BOTTLE CAPS	10,000	B	7
22	GUTTERS	7,000	B	7
23	METAL DOORS - EXCLUDING GARAGE DOORS	7,000	B	7
24	ALUMINUM SIDING AND ROOFING	4,000	B	7
25	ELECTRIC FANS	3,000	B	2
26	DOOR AND WINDOW FRAMES	3,000	B	7
27	GARAGE DOORS	3,000	B	7
28	REFRIGERATORS	2,000	B	1
29	FILING CABINETS	1,000	B	8
30	BEDROOM FURNITURE	1,000	B	6
31	ENAMELED PLUMBING FIXTURES	1,000	B	1
32	TABLES	1,000	B	6
33	LAMPS	1,000	B	2
34	SPINNING FRAMES	1,000	B	4
35	RADIOS AND TELEVISIONS	1,000	B	1
36	CABINETS	1,000	B	6
37	DRYERS	1,000	B	1
38	RAILINGS, FIRE ESCAPES, STAIRCASES	1,000	B	7
39	DESKS	900	B	6
40	WASHERS	900	B	1
41	PUMPS	900	B	4
42	COMPRESSORS	800	B	4
43	FREEZERS	700	B	1
44	TABLES	700	B	8
45	STOVES	700	B	1
46	WATER HEATERS	600	B	1
47	VENDING MACHINES	600	B	5
48	CHAIRS	600	B	8
49	CARPET CARE APPLIANCES	600	B	2
50	TWISTING FRAMES	600	B	4
51	ELECTRIC TOOLS	500	B	2
52	CHAIRS	400	B	6
53	AIR CONDITIONERS	400	B	1
54	COFFEE POTS	400	B	2
55	FURNACES	300	B	1
56	COAT RACKS	300	C	8

Table 22 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 2

(Oxidants Priority List)

57	BATHROOM SCALES	300	B	2
58	DISHWASHERS	300	B	1
59	PHONOGRAPHS	300	B	2
60	SEWING MACHINES	300	B	2
61	ROTARY DRILLING EQUIPMENT - SUBSURFACE	200	B	4
62	TYPEWRITERS	200	B	5
63	BOXES AND RACKS	200	B	3
64	SAFES AND VAULTS	200	B	8
65	AUTOMOTIVE MAINTENANCE EQUIPMENT	200	C	4
66	ELECTRIC COOKWARE	200	B	2
67	BLENDERS	200	B	2
68	PROJECTORS - MOVIE AND SLIDE	200	B	2
69	MIXERS	200	B	2
70	PERMANENT CRISPNESS	200	C	10
71	SAWING MACHINES - WOOD	200	B	4
72	DESKS	200	B	6
73	SHELVING	200	C	7
74	CABINETS	200	C	8
75	FARM WAGONS	100	B	3
76	SPACE HEATERS	100	B	2
77	MAILING AND PARCEL POST SCALES	100	B	5
78	LAWN MOWERS	100	B	1
79	IRONS	100	B	2
80	GARBAGE DISPOSALS	100	B	2
81	WIRE PRODUCTS	90	C	7
82	HUMIDIFIERS	90	B	1
83	HAND SPRAYERS	80	B	3
84	FARM ELEVATORS - PORTABLE	80	B	3
85	WASTE CANS	80	C	8
86	GRINDING AND POLISHING MACHINES	80	B	4
87	TRACTORS	70	B	3
88	BLEACHING, DRYING, FINISHING MACHINERY	70	C	4
89	STEEL SHIPPING BARRELS	70	B	7
90	PACKING, PACKAGING, BOTTLING MACHINERY	70	B	4
91	DUPLICATING MACHINES	70	B	5
92	CAMERAS	60	B	2
93	REBUILT PULP AND PAPERMILL MACHINERY	60	C	4
94	LATHES, PLANERS, ETC. - WOOD	60	C	4
95	BOOKCASES	60	B	6
96	PRESSES - METAL	50	B	4
97	CHOPPERS, GRINDERS, CUTTERS, ETC. - FOOD	50	B	4
98	POULTRY FEEDERS	50	C	3
99	SNOW BLOWERS	50	B	2
100	COMBINES	50	B	3
101	DEHUMIDIFIERS	50	B	1
102	ADDING MACHINES	50	B	5
103	WELDING AND CUTTING APPARATUS	50	C	4
104	INDUSTRIAL TRUCKS	40	B	4
105	BROODERS	40	B	3
106	TOASTERS	40	C	2
107	INDUSTRIAL WATER SOFTENERS	40	B	5
108	ELECTRIC RAZORS	40	B	2
109	PUNCHING AND SHEARING MACHINES	40	B	4
110	DRILLING MACHINES	30	B	4
111	BENDING AND FORMING MACHINES	30	B	4
112	GASOLINE PUMPS	30	B	5
113	MAILING MACHINES	30	B	5
114	FLOWING WELL EQUIPMENT	30	C	4
115	STACK SHREDDERS	30	B	3
116	WOOD PREPARATION EQUIPMENT - PULPMILLS	30	C	4

Table 22 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 2

(Oxidants Priority List)

117	FORAGE BLOWERS	30	B	3
118	METAL CLEANING MACHINERY	20	C	4
119	KNITTING MACHINES	20	B	4
120	HOG FEEDING EQUIPMENT	20	B	3
121	CAN OPENERS AND KNIFE SHARPENERS	20	B	2
122	CHEMICAL MANUFACTURING INDUSTRIAL MACH	20	C	4
123	TRASH COMPACTORS	20	B	1
124	FRUIT AND VEGETABLE CANNING MACHINERY	20	C	4
125	TAPE RECORDERS	20	C	2
126	LATHES - METAL	20	B	4
127	NESTS AND CAGES	20	B	3
128	TIME RECORDERS	20	B	5
129	TURKEY FEEDERS	20	B	3
130	JOINTERS	20	C	4
131	MEAT AND POULTRY PROCESSING MACHINERY	20	C	4
132	WATER SOFTENERS	20	B	1
133	PLASTICS WORKING MACHINERY	20	B	4
134	CEMENT MAKING MACHINERY	20	C	4
135	HOISTS	20	B	4
136	HAIR DRYERS	20	C	2
137	COMMERCIAL DISHWASHERS	10	B	5
138	MOTOR TRUCK SCALES	10	B	5
139	CHAIN SAWS	10	B	4
140	FORMS HANDLING EQUIPMENT	10	B	5
141	ROD LIFTING MACHINERY - OIL	10	C	4
142	PAPER AND PAPERBOARD CONVERTING MACHINER	10	B	4
143	CHECK HANDLING MACHINES	10	B	5
144	COTTON GINNING MACHINERY	10	C	4
145	BOOK CASES	10	B	4
146	MINE CARS, TRACK	10	B	4
147	SUGAR PLANT PROCESSING MACHINERY	10	C	4
148	MANURE SPREADERS	10	B	3
149	BALE THROWING ATTACHMENTS	10	B	3
150	BROADCAST SEEDERS	10	B	3
151	DAIRY MACHINES	10	B	3
152	MILLING MACHINES	9	B	4
153	FERTILIZER DISTRIBUTORS	9	B	3
154	HAND DUSTERS	9	B	3
155	TYPESETTING MACHINERY	8	B	4
156	YARN PREPARING MACHINES	8	B	4
157	SAWMILL EQUIPMENT	8	C	4
158	CASH REGISTERS	8	C	5
159	TOBACCO MANUFACTURING MACHINES	7	B	4
160	SCREENS - MINING	7	B	4
161	OTHER SPRAYERS - NON-TRACTOR	7	B	4
162	FIELD FORAGE HARVESTORS	7	B	3
163	CLAYWORKING MACHINER	7	C	4
164	OFF-SET LITHOGRAPHIC PRESSES	6	B	4
165	DRYERS	6	B	3
166	DICTATING MACHINES	6	B	5
167	ACCOUNTING MACHINES	6	C	5
168	CONSTRUCTION CRANES	5	B	4
169	SAWING AND CUTOFF MACHINES - METAL	5	B	4
170	FOGGERS AND MIST SPRAYERS	5	B	3
171	FEEDERS	5	B	4
172	CLEANING AND OPENING MACHINES	5	B	4
173	OVERHEAD CRANES	5	B	4
174	POWER SPRAYERS	5	B	3
175	SHOEMAKING MACHINERY	5	C	4
176	MOTORIZED HAND TRUCKS	5	B	4

Table 22 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 2

(Oxidants Priority List)

177	ROTARY CULTIVATORS	5	B	3
178	CRUSHERS	5	B	4
179	HOG WATERING EQUIPMENT	5	B	3
180	BLADE TERRACERS	5	B	3
181	PAPERMILL MACHINERY	4	B	4
182	MOWER-CONDITIONERS	4	B	3
183	INCUBATORS	4	B	3
184	EXCAVATORS	4	B	4
185	PEANUT COMBINES	4	B	3
186	PLANERS - METAL	4	C	4
187	COMMERCIAL FLOOR WAXERS	4	B	5
188	HOT ROLLING MILL MACHINES	3	C	4
189	FARM ELEVATORS - STATIONARY	3	B	3
190	ICE CREAM FREEZERS	3	C	4
191	CONCRETE PRODUCT MACHINERY	3	B	4
192	MOWERS	3	B	3
193	SHUTTLE CARS - MINING	3	B	4
194	HARROWS	3	B	3
195	RETAIL AND COMMERCIAL SCALES	3	B	5
196	HAY BALERS	3	B	3
197	FEED GRINDERS	3	B	3
198	FLOUR AND GRAIN MILL MACHINERY	3	C	4
199	COLD ROLLING MILL MACHINES	3	C	4
200	HAY CONDITIONERS	2	B	3
201	FLOTATION MACHINES	2	B	4
202	GLASS MAKING MACHINERY	2	B	4
203	CORN AND COTTON CULTIVATORS	2	B	3
204	MOLDBOARD PLOWS	2	B	3
205	GEAR CUTTING MACHINES	2	B	4
206	CLASSIFIERS	2	B	4
207	LETTERSET PRINTING PRESSES	2	B	4
208	BINDERY EQUIPMENT	2	B	4
209	LOADING, CUTTING, LONGWALL MINING MACH	2	B	4
210	FIELD CULTIVATORS	2	B	3
211	AIR-CARRIED TYPE POWER SPRAYER	2	B	3
212	WINDROWERS - HAY	2	B	3
213	DRILLS - MINING	2	B	4
214	FOUNDRY MACHINERY	2	C	4
215	VENEER AND PLYWOOD EQUIPMENT	2	C	4
216	CARDING AND COMBING MACHINES	1	B	4
217	HAY STACKING ATTACHMENTS	1	B	3
218	CORN SHELLERS	1	C	3
219	ELECTRONIC TUBE MANUFACTURING MACHINERY	1	C	4
220	COMMERCIAL CARPET SWEEPERS	1	B	5
221	CORN PICKERS	1	B	3
222	PULPMILL MACHINERY	1	B	4
223	GRINDING MILLS	1	B	4
224	MAGNETIC SEPARATORS	1	B	4
225	HOMOGENIZERS AND PASTEURIZERS	1	B	4
226	CENTRIFUGAL DRIERS	1	B	4
227	CONCRETE MIXERS	1	B	4
228	CORN PLNTRS, LISTERS, POTATO PLNTRS, TRN	1	B	3
229	BAKERY MACHINERY	1	B	4
230	FRONT AND REAR MOUNTED LOADERS	1	B	3
231	PEANUT DIGGERS	1	B	3
232	TAPPING MACHINES	1	B	4
233	BORING MACHINES	1	B	4
234	CONTINUOUS MINING MACHINES	1	B	4
235	ELECTRONIC CALCULATORS	1	B	5
236	LAND LEVELERS	1	B	3

Table 22 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 2

(Oxidants Priority List)

237	WET CYCLONES - MINING	1	B	4
238	HAY BALE LOADERS	1	B	3
239	BUTTER AND CHEESE PROCESSING MACHINERY	1	B	4
240	MANURE PUMPS	1	B	3
241	RAKES	1	B	3
242	COTTON STRIPPERS	1	B	3
243	SCRUBBERS - MINING	1	B	4
244	GRAIN DRILLS	1	C	3
245	FEED MIXERS	1	B	3
246	POWER DUSTERS	1	B	3
247	SUBSOILERS - DEEP TILLAGE	1	B	3
248	GRAVURE PRINTING PRESSES	1	B	4
249	MIDDLEBUSTERS AND DISC BEDDERS	1	B	3
250	THERMAL DRIERS - MINING	1	B	4
251	CHISEL PLOWS	1	B	3
252	BEET HARVESTORS	1	B	3
253	CONCENTRATING TABLES	1	B	4
254	TERRACING AND DITCHING PLOWS	1	B	3
255	TOBACCO CURERS	1	B	3
256	POTATO HARVESTORS	1	B	3
257	WINDROWERS OR SWATHERS	1	B	3
258	FLEXOGRAPHIC PRINTING PRESSES	1	B	4
259	TURKEY WATERERS	1	C	3
260	BROACHING MACHINES	1	B	4
261	ROTARY DRILLING EQUIPMENT - SURFACE	1	B	4
262	WASHING AND STERILIZING EQUIPMENT	1	C	4
263	ROD WEEDERS	1	B	3
264	SHAPERS - METAL	1	B	4
265	BEET, BEAN, AND VEGETABLE CULTIVATORS	1	B	3
266	DISC PLOWS	1	B	3
267	EGG GRADERS	1	B	3
268	EGG WASHERS	1	B	3

Table 23. EVAPORATION FROM SURFACE COATINGS: OPTION 3
(Worst Case Priority List)

RANK	SOURCE TYPE	IMPACT FACTOR	CL	CAT
1	COATED PAPER - EXCLUDING WAXED	10,000,000	B	9
2	PRINTING PAPER	6,000,000	B	9
3	PAPER BOXES	2,000,000	B	9
4	MILK CARTON BOARD	2,000,000	B	9
5	OILED AND WAXED PAPER	1,000,000	B	9
6	SIZING	1,000,000	C	10
7	METAL CANS - EXCLUDING BEVERAGE CANS	1,000,000	B	7
8	DYEING	900,000	C	10
9	BEVERAGE CANS	700,000	B	7
10	FOLDING CARTONS	700,000	B	9
11	PAPER BAGS	500,000	B	9
12	KRAFT PAPER	300,000	B	9
13	DUCTWORK	200,000	C	7
14	PAPER CANS, TUBES, DRUMS	200,000	B	9
15	WOOD PANELING	200,000	C	7
16	WRINKLE RESISTANT FINISHES	70,000	C	10
17	CANOPIES AND AWNINGS	50,000	C	7
18	SCREENING	50,000	B	7
19	FENCING	30,000	B	7
20	WATER PROOF AND WATER REPELLENT FINISHES	20,000	C	10
21	BEER AND SOFT DRINK BOTTLE CAPS	10,000	B	7
22	REFRIGERATORS	10,000	B	1
23	GUTTERS	10,000	B	7
24	METAL DOORS - EXCLUDING GARAGE DOORS	10,000	B	7
25	FILING CABINETS	10,000	B	8
26	ENAMELED PLUMBING FIXTURES	9,000	B	1
27	PUMPS	9,000	B	4
28	BEDROOM FURNITURE	9,000	B	6
29	TABLES	8,000	B	6
30	SPINNING FRAMES	8,000	B	4
31	CABINETS	7,000	B	6
32	DESKS	7,000	B	8
33	RADIOS AND TELEVISIONS	6,000	B	1
34	ALUMINUM SIDING AND ROOFING	6,000	B	7
35	COMPRESSORS	6,000	B	4
36	DRYERS	5,000	B	1
37	WASHERS	5,000	B	1
38	TABLES	5,000	B	8
39	STOVES	5,000	B	1
40	ELECTRIC FANS	5,000	B	2
41	CHAIRS	5,000	B	8
42	VENDING MACHINES	5,000	B	5
43	TWISTING FRAMES	4,000	B	4
44	FREEZERS	4,000	B	1
45	WATER HEATERS	4,000	B	1
46	GARAGE DOORS	4,000	B	7
47	DOOR AND WINDOW FRAMES	3,000	B	7
48	CHAIRS	3,000	B	6
49	AIR CONDITIONERS	2,000	B	1
50	COAT RACKS	2,000	C	8
51	FURNACES	2,000	B	1
52	AUTOMOTIVE MAINTENANCE EQUIPMENT	2,000	C	4
53	LAMPS	2,000	B	2
54	ROTARY DRILLING EQUIPMENT - SUBSURFACE	2,000	B	4
55	TYPEWRITERS	2,000	B	5
56	DISHWASHERS	2,000	B	1

Table 23 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 3
(Worst Case Priority List)

57	BOXES AND RACKS	1,000	B	3
58	SAFES AND VAULTS	1,000	B	8
59	RAILINGS, FIRE ESCAPES, STAIRCASES	1,000	B	7
60	SAWING MACHINES - WOOD	1,000	B	4
61	CARPET CARE APPLIANCES	1,000	B	2
62	DESKS	1,000	B	6
63	CABINETS	1,000	C	8
64	PERMANENT CRISPNESS	1,000	C	10
65	FARM WAGONS	1,000	B	3
66	LAWN MOWERS	800	B	1
67	MAILING AND PARCEL POST SCALES	800	B	5
68	BLEACHING, DRYING, FINISHING MACHINERY	700	C	4
69	PACKING, PACKAGING, BOTTLING MACHINERY	700	B	4
70	PHONOGRAPHS	600	B	2
71	REBUILT PULP AND PAPERMILL MACHINERY	600	C	4
72	ELECTRIC TOOLS	600	B	2
73	FARM ELEVATORS - PORTABLE	600	B	3
74	HAND SPRAYERS	600	B	3
75	COFFEE POTS	600	B	2
76	WASTE CANS	600	C	8
77	GRINDING AND POLISHING MACHINES	600	B	4
78	BATHROOM SCALES	600	B	2
79	CHOPPERS, GRINDERS, CUTTERS, ETC. - FOOD	500	B	4
80	TRACTORS	500	B	3
81	SEWING MACHINES	500	B	2
82	DUPLICATING MACHINES	500	C	5
83	HUMIDIFIERS	500	B	1
84	LATHES, PLANERS, ETC. - WOOD	400	C	4
85	PRESSES - METAL	400	B	4
86	POULTRY FEEDERS	400	C	3
87	BOOKCASES	400	B	3
88	COMBINES	400	B	3
89	INDUSTRIAL WATER SOFTENERS	400	B	5
90	WELDING AND CUTTING APPARATUS	300	C	4
91	PROJECTORS - MOVIE AND SLIDE	300	B	2
92	ELECTRIC COOKWARE	300	B	2
93	INDUSTRIAL TRUCKS	300	B	4
94	MIXERS	300	B	2
95	BLENDERS	300	B	2
96	DEHUMIDIFIERS	300	B	1
97	PUNCHING AND SHEARING MACHINES	300	B	4
98	DRILLING MACHINES	200	B	4
99	BENDING AND FORMING MACHINES	200	B	4
100	GASOLINE PUMPS	200	B	5
101	SPACE HEATERS	200	B	2
102	SHELVING	200	C	7
103	MAILING MACHINES	200	B	5
104	FLOWING WELL EQUIPMENT	200	C	4
105	CHEMICAL MANUFACTURING INDUSTRIAL MACH	200	C	4
106	STACK SHREDDERS	200	B	3
107	WOOD PREPARATION EQUIPMENT - PULPMILLS	200	C	4
108	FORAGE BLOWERS	200	B	3
109	METAL CLEANING MACHINERY	200	C	4
110	GARBAGE DISPOSALS	200	B	2
111	FRUIT AND VEGETABLE CANNING MACHINERY	200	C	4
112	IRONS	200	B	2
113	MEAT AND POULTRY PROCESSING MACHINERY	200	C	4
114	KNITTING MACHINES	200	B	4
115	CEMENT MAKING MACHINERY	200	C	4
116	HOG FEEDING EQUIPMENT	200	B	3

Table 23 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 3
(Worst Case Priority List)

117	TRASH COMPACTORS	100	B	1
118	WIRE PRODUCTS	100	C	7
119	LATHES - METAL	100	B	4
120	NESTS AND CAGES	100	B	3
121	CHAIN SAWS	100	B	4
122	TURKEY FEEDERS	100	B	5
123	CAMERAS	100	B	2
124	JOINTERS	100	C	4
125	PAPER AND PAPERBOARD CONVERTING MACHINER	100	B	4
126	PLASTICS WORKING MACHINERY	100	B	4
127	HOISTS	100	B	4
128	WATER SOFTENERS	100	B	1
129	SNOW BLOWERS	100	B	2
130	ADDING MACHINES	100	B	5
131	TIME RECORDERS	100	B	5
132	MOTOR TRUCK SCALES	100	B	5
133	FORMS HANDLING EQUIPMENT	100	B	5
134	BROODERS	90	B	3
135	COMMERCIAL DISHWASHERS	90	B	5
136	ROD LIFTING MACHINERY - OIL	90	C	4
137	STEEL SHIPPING BARRELS	90	B	7
138	CHECK HANDLING MACHINES	80	B	5
139	COTTON GINNING MACHINERY	80	C	4
140	MINE CARS, TRACK	80	B	4
141	SUGAR PLANT PROCESSING MACHINERY	80	C	4
142	BOOK CASES	80	B	8
143	MANURE SPREADERS	80	B	3
144	BALE THROWING ATTACHMENTS	80	B	3
145	TOASTERS	80	C	2
146	BROADCAST SEEDERS	70	B	3
147	DAIRY MACHINES	70	B	3
148	MILLING MACHINES	70	B	4
149	FERTILIZER DISTRIBUTORS	70	B	3
150	ELECTRIC RAZORS	60	B	2
151	HAND DUSTERS	60	B	3
152	TYPESETTING MACHINERY	60	B	4
153	YARN PREPARING MACHINES	60	B	4
154	SAWMILL EQUIPMENT	60	C	4
155	CASH REGISTERS	60	C	5
156	TOBACCO MANUFACTURING MACHINES	50	B	4
157	OTHER SPRAYERS - NON-TRACTOR	50	B	3
158	SCREENS - MINING	50	B	4
159	FIELD FORAGE HARVESTORS	50	B	3
160	CLAYWORKING MACHINER	50	C	4
161	DICTATING MACHINES	50	B	5
162	OFF-SET LITHOGRAPHIC PRESSES	50	B	4
163	DRYERS	50	B	3
164	PAPERMILL MACHINERY	50	B	4
165	ACCOUNTING MACHINES	40	C	5
166	CONSTRUCTION CRANES	40	B	4
167	FOGGERS AND MIST SPRAYERS	40	B	3
168	SAWING AND CUTOFF MACHINES - METAL	40	B	4
169	FEEDERS	40	B	4
170	CLEANING AND OPENING MACHINES	40	B	4
171	POWER SPRAYERS	40	B	3
172	OVERHEAD CRANES	40	B	4
173	TAPE RECORDERS	40	C	2
174	SHOEMAKING MACHINERY	40	C	4
175	MOTORIZED HAND TRUCKS	40	B	4
176	ROTARY CULTIVATORS	40	B	3

Table 23 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 3
(Worst Case Priority List)

177	CRUSHERS	30	B	4
178	HOG WATERING EQUIPMENT	30	B	3
179	BLADE TERRACERS	30	B	3
180	ICE CREAM FREEZERS	30	C	4
181	MOWER-CONDITIONERS	30	B	3
182	INCUBATORS	30	B	3
183	EXCAVATORS	30	B	4
184	CAN OPENERS AND KNIFE SHARPENERS	30	B	2
185	PEANUT COMBINES	30	B	3
186	PLANERS - METAL	30	C	4
187	COMMERCIAL FLOOR WAXERS	30	B	5
188	HAIR DRYERS	30	C	2
189	HOT ROLLING MILL MACHINES	30	C	4
190	FARM ELEVATORS - STATIONARY	30	B	3
191	CONCRETE PRODUCT MACHINERY	20	B	4
192	MOWERS	20	B	3
193	SHUTTLE CARS - MINING	20	B	4
194	RETAIL AND COMMERCIAL SCALES	20	B	5
195	FEED GRINDERS	20	B	3
196	HAY BALERS	20	B	3
197	FLOUR AND GRAIN MILL MACHINERY	20	C	4
198	HARROWS	20	B	3
199	COLD ROLLING MILL MACHINES	20	C	4
200	HAY CONDITIONERS	20	B	3
201	FLOTATION MACHINES	20	B	4
202	GLASS MAKING MACHINERY	20	B	4
203	CORN AND COTTON CULTIVATORS	20	B	3
204	MOLDBOARD PLOWS	20	B	3
205	GEAR CUTTING MACHINES	10	B	4
206	CLASSIFIERS	10	B	4
207	LETTERSET PRINTING PRESSES	10	B	4
208	BINDERY EQUIPMENT	10	B	4
209	LOADING, CUTTING, LONGWALL MINING MACH	10	B	4
210	FIELD CULTIVATORS	10	B	3
211	AIR-CARRIED TYPE POWER SPRAYER	10	B	3
212	DRILLS - MINING	10	B	4
213	WINDROWERS - HAY	10	B	3
214	FOUNDRY MACHINERY	10	C	4
215	VENEER AND PLYWOOD EQUIPMENT	10	C	4
216	PULPMILL MACHINERY	10	B	4
217	CARDING AND COMBING MACHINES	10	B	4
218	HAY STACKING ATTACHMENTS	10	B	3
219	CORN SHELLERS	10	C	3
220	ELECTRONIC TUBE MANUFACTURING MACHINERY	9	C	4
221	COMMERCIAL CARPET SWEEPERS	9	B	5
222	CORN PICKERS	8	B	3
223	GRINDING MILLS	8	B	4
224	MAGNETIC SEPARATORS	7	B	4
225	HOMOGENIZERS AND PASTEURIZERS	7	B	4
226	CENTRIFUGAL DRIERS	7	B	4
227	CONCRETE MIXERS	7	B	4
228	CORN PLNTRS, LISTERS, POTATO PLNTRS, TRN	6	B	3
229	BAKERY MACHINERY	6	B	4
230	FRONT AND REAR MOUNTED LOADERS	5	B	3
231	PEANUT DIGGERS	5	B	3
232	TAPPING MACHINES	5	B	4
233	BORING MACHINES	5	B	4
234	CONTINUOUS MINING MACHINES	5	B	4
235	ELECTRONIC CALCULATORS	4	B	5
236	BUTTER AND CHEESE PROCESSING MACHINERY	4	B	4

Table 23 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 3
(Worst Case Priority List)

237	WET CYCLONES - MINING	4	B	4
238	HAY BALE LOADERS	3	B	3
239	MANURE PUMPS	3	B	3
240	RAKES	3	B	3
241	COTTON STRIPPERS	2	B	3
242	SCRUBBERS - MINING	2	B	4
243	GRAIN DRILLS	2	C	3
244	FEED MIXERS	2	B	3
245	POWER DUSTERS	2	B	3
246	GRAVURE PRINTING PRESSES	2	B	4
247	SUBSOILERS - DEEP TILLAGE	2	B	3
248	MIDDLEBUSTERS AND DISC BEDDERS	2	B	3
249	THERMAL DRIERS - MINING	2	B	4
250	BEET HARVESTORS	1	B	3
251	CHISEL PLOWS	1	B	3
252	CONCENTRATING TABLES	1	B	4
253	TERRACING AND DITCHING PLOWS	1	B	3
254	TOBACCO CURERS	1	B	3
255	POTATO HARVESTORS	1	B	3
256	LAND LEVELERS	1	B	3
257	WINDROWERS OR SWATHERS	1	B	3
258	FLEXOGRAPHIC PRINTING PRESSES	1	B	4
259	TURKEY WATERERS	1	C	3
260	BROACHING MACHINES	1	B	4
261	ROTARY DRILLING EQUIPMENT - SURFACE	1	B	4
262	WASHING AND STERILIZING EQUIPMENT	1	C	4
263	ROD WEEDERS	1	B	3
264	SHAPERS - METAL	1	B	4
265	BEET, BEAN, AND VEGETABLE CULTIVATORS	1	B	3
266	DISC PLOWS	1	B	3
267	EGG WASHERS	1	B	3
268	EGG GRADERS	1	B	3

Table 24. EVAPORATION FROM SURFACE COATINGS: OPTION 4 (Mass of Hydrocarbon Emissions)

RANK	SOURCE TYPE	EMISSION RATE	CL	CAT
1	PAPER BAGS	200,000,000,000	B	9
2	METAL CANS - EXCLUDING BEVERAGE CANS	200,000,000,000	B	7
3	DYEING	200,000,000,000	C	10
4	BEVERAGE CANS	200,000,000,000	B	7
5	KRAFT PAPER	70,000,000,000	B	9
6	COATED PAPER - EXCLUDING WAXED	70,000,000,000	B	9
7	PRINTING PAPER	50,000,000,000	B	9
8	DUCTWORK	40,000,000,000	C	7
9	OILED AND WAXED PAPER	40,000,000,000	B	9
10	MILK CARTON BOARD	20,000,000,000	B	9
11	PAPER BOXES	20,000,000,000	B	9
12	WOOD PANELING	10,000,000,000	C	7
13	CANOPIES AND AWNINGS	10,000,000,000	C	7
14	SIZING	10,000,000,000	C	10
15	REFRIGERATORS	7,000,000,000	B	1
16	FOLDING CARTONS	5,000,000,000	B	9
17	SCREENING	5,000,000,000	B	7
18	FENCING	4,000,000,000	B	7
19	BEDROOM FURNITURE	4,000,000,000	B	6
20	ENAMELED PLUMBING FIXTURES	3,000,000,000	B	1
21	DRYERS	3,000,000,000	B	1
22	WASHERS	3,000,000,000	B	1
23	FILING CABINETS	3,000,000,000	B	8
24	METAL DOORS - EXCLUDING GARAGE DOORS	2,000,000,000	B	7
25	GUTTERS	2,000,000,000	B	7
26	TABLES	2,000,000,000	B	6
27	STOVES	2,000,000,000	B	1
28	CABINETS	2,000,000,000	B	6
29	PUMPS	2,000,000,000	B	4
30	DESKS	2,000,000,000	B	8
31	ALUMINUM SIDING AND ROUFING	2,000,000,000	B	7
32	RADIOS AND TELEVISIONS	2,000,000,000	B	1
33	PAPER CANS, TUBES, DRUMS	2,000,000,000	B	9
34	SPINNING FRAMES	2,000,000,000	B	4
35	FREEZERS	2,000,000,000	B	1
36	WATER HEATERS	1,000,000,000	B	1
37	BEER AND SOFT DRINK BOTTLE CAPS	1,000,000,000	B	7
38	TABLES	1,000,000,000	B	8
39	CHAIRS	1,000,000,000	B	8
40	TWISTING FRAMES	1,000,000,000	B	4
41	ELECTRIC FANS	1,000,000,000	B	2
42	AIR CONDITIONERS	1,000,000,000	B	1
43	FURNACES	1,000,000,000	B	1
44	DISHWASHERS	1,000,000,000	B	1
45	WRINKLE RESISTANT FINISHES	800,000,000	C	10
46	CHAIRS	700,000,000	B	6
47	GARAGE DOORS	600,000,000	B	7
48	DOOR AND WINDOW FRAMES	600,000,000	B	7
49	VENDING MACHINES	600,000,000	B	5
50	COMPRESSORS	600,000,000	B	4
51	COAT RACKS	600,000,000	C	8
52	ROTARY DRILLING EQUIPMENT - SUBSURFACE	500,000,000	B	4
53	LAWN MOWERS	400,000,000	B	1
54	SAFES AND VAULTS	400,000,000	B	8
55	TRACTORS	400,000,000	B	3
56	LAMPS	400,000,000	B	2

Table 24 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 4
(Mass of Hydrocarbon Emissions)

57	DESKS	300,000,000	B	6
58	CARPET CARE APPLIANCES	300,000,000	B	2
59	RAILINGS, FIRE ESCAPES, STAIRCASES	300,000,000	B	7
60	CABINETS	300,000,000	C	8
61	AUTOMOTIVE MAINTENANCE EQUIPMENT	300,000,000	C	4
62	POULTRY FEEDERS	200,000,000	C	3
63	HUMIDIFIERS	200,000,000	B	1
64	SAWING MACHINES - WOOD	200,000,000	B	4
65	FARM WAGONS	200,000,000	B	3
66	HAND SPRAYERS	200,000,000	B	3
67	PHONOGRAPHS	200,000,000	B	2
68	PERMANENT CRISPNESS	200,000,000	C	10
69	BATHROOM SCALES	100,000,000	B	2
70	BOXES AND RACKS	100,000,000	B	3
71	WASTE CANS	100,000,000	C	8
72	MIXERS	100,000,000	B	2
73	TYPEWRITERS	100,000,000	B	5
74	ELECTRIC TOOLS	100,000,000	B	2
75	FARM ELEVATORS - PORTABLE	100,000,000	B	3
76	BOOKCASES	100,000,000	B	6
77	MEAT AND POULTRY PROCESSING MACHINERY	100,000,000	C	4
78	SEWING MACHINES	100,000,000	B	2
79	COFFEE POTS	90,000,000	B	2
80	DEHUMIDIFIERS	80,000,000	B	1
81	GARBAGE DISPOSALS	80,000,000	B	2
82	ELECTRIC COOKWARE	80,000,000	B	2
83	CHAIN SAWS	70,000,000	B	4
84	FLOWING WELL EQUIPMENT	70,000,000	C	4
85	PACKING, PACKAGING, BOTTLING MACHINERY	70,000,000	B	4
86	CHOPPERS, GRINDERS, CUTTERS, ETC. - FOOD	70,000,000	B	4
87	SPACE HEATERS	70,000,000	B	2
88	PROJECTORS - MOVIE AND SLIDE	70,000,000	B	2
89	LATHES, PLANERS, ETC. - WOOD	70,000,000	C	4
90	HOG FEEDING EQUIPMENT	60,000,000	B	3
91	COMBINES	60,000,000	B	3
92	IRONS	60,000,000	B	2
93	GRINDING AND POLISHING MACHINES	60,000,000	B	4
94	DUPLICATING MACHINES	50,000,000	B	5
95	BLENDERS	50,000,000	B	2
96	MAILING AND PARCEL POST SCALES	50,000,000	B	5
97	SNOW BLOWERS	50,000,000	B	2
98	PRESSES - METAL	50,000,000	B	4
99	WOOD PREPARATION EQUIPMENT - PULPMILLS	50,000,000	C	4
100	INDUSTRIAL TRUCKS	50,000,000	B	4
101	WATER SOFTENERS	40,000,000	B	1
102	BLEACHING, DRYING, FINISHING MACHINERY	40,000,000	C	4
103	NESTS AND CAGES	40,000,000	B	3
104	TURKEY FEEDERS	40,000,000	B	3
105	SHELVING	40,000,000	C	7
106	GASOLINE PUMPS	30,000,000	B	5
107	STACK SHREDDERS	30,000,000	B	3
108	CAMERAS	30,000,000	B	2
109	REBUILT PULP AND PAPERMILL MACHINERY	30,000,000	C	4
110	INDUSTRIAL WATER SOFTENERS	30,000,000	B	5
111	TRASH COMPACTORS	30,000,000	B	1
112	PUNCHING AND SHEARING MACHINES	30,000,000	B	4
113	BROODERS	30,000,000	B	3
114	ROD LIFTING MACHINERY - OIL	30,000,000	C	4
115	BOOK CASES	30,000,000	B	8
116	FORAGE BLOWERS	20,000,000	B	3

Table 24 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 4
(Mass of Hydrocarbon Emissions)

117	DAIRY MACHINES	20,000,000	B	3
118	WELDING AND CUTTING APPARATUS	20,000,000	C	4
119	BENDING AND FORMING MACHINES	20,000,000	B	4
120	DRILLING MACHINES	20,000,000	B	4
121	MAILING MACHINES	20,000,000	B	5
122	FRUIT AND VEGETABLE CANNING MACHINERY	20,000,000	C	4
123	JOINTERS	20,000,000	C	4
124	HOG WATERING EQUIPMENT	20,000,000	B	3
125	METAL CLEANING MACHINERY	20,000,000	C	4
126	CHEMICAL MANUFACTURING INDUSTRIAL MACH	20,000,000	C	4
127	TOASTERS	20,000,000	C	2
128	ADDING MACHINES	20,000,000	B	5
129	MILLING MACHINES	20,000,000	B	4
130	STEEL SHIPPING BARRELS	20,000,000	B	7
131	CONSTRUCTION CRANES	20,000,000	B	4
132	CEMENT MAKING MACHINERY	20,000,000	C	4
133	BALE THROWING ATTACHMENTS	20,000,000	B	3
134	WIRE PRODUCTS	20,000,000	C	7
135	MANURE SPREADERS	20,000,000	B	3
136	BROADCAST SEEDERS	20,000,000	B	3
137	CASH REGISTERS	20,000,000	C	5
138	COMMERCIAL DISHWASHERS	20,000,000	B	5
139	SAWMILL EQUIPMENT	20,000,000	C	4
140	CHECK HANDLING MACHINES	10,000,000	B	5
141	HOISTS	10,000,000	B	4
142	FERTILIZER DISTRIBUTORS	10,000,000	B	3
143	COTTON GINNING MACHINERY	10,000,000	C	4
144	KNITTING MACHINES	10,000,000	B	4
145	TYPESETTING MACHINERY	10,000,000	B	4
146	OVERHEAD CRANES	10,000,000	B	4
147	ELECTRIC RAZORS	10,000,000	B	2
148	LATHES - METAL	10,000,000	B	4
149	MINE CARS, TRACK	10,000,000	B	4
150	MOTOR TRUCK SCALES	10,000,000	B	5
151	HAIR DRYERS	10,000,000	C	2
152	WATER PROOF AND WATER REPELLENT FINISHES	9,000,000	C	10
153	FIELD FORAGE HARVESTORS	9,000,000	B	3
154	FORMS HANDLING EQUIPMENT	9,000,000	B	5
155	PLASTICS WORKING MACHINERY	8,000,000	B	4
156	ROTARY CULTIVATORS	8,000,000	B	3
157	TAPE RECORDERS	8,000,000	C	2
158	PAPER AND PAPERBOARD CONVERTING MACHINER	8,000,000	B	4
159	BLADE TERRACERS	8,000,000	B	3
160	SUGAR PLANT PROCESSING MACHINERY	8,000,000	C	4
161	OTHER SPRAYERS - NON-TRACTOR	8,000,000	B	3
162	HAND DUSTERS	8,000,000	B	3
163	TIME RECORDERS	7,000,000	B	5
164	PEANUT COMBINES	7,000,000	B	3
165	DRYERS	7,000,000	B	3
166	MOWER-CONDITIONERS	7,000,000	B	3
167	DICTATING MACHINES	7,000,000	B	5
168	INCUBATORS	6,000,000	B	3
169	FOGGERS AND MIST SPRAYERS	6,000,000	B	3
170	MOTORIZED HAND TRUCKS	6,000,000	B	4
171	YARN PREPARING MACHINES	6,000,000	B	4
172	POWER SPRAYERS	6,000,000	B	3
173	FARM ELEVATORS - STATIONARY	6,000,000	B	3
174	SCREENS - MINING	6,000,000	B	4
175	CLEANING AND OPENING MACHINES	5,000,000	B	4
176	CRUSHERS	5,000,000	B	4

Table 24 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 4
(Mass of Hydrocarbon Emissions)

177	MOWERS	5,000,000	B	3
178	HARROWS	5,000,000	B	3
179	CAN OPENERS AND KNIFE SHARPENERS	5,000,000	B	2
180	PAPERMILL MACHINERY	5,000,000	B	4
181	EXCAVATORS	5,000,000	B	4
182	SAWING AND CUTOFF MACHINES - METAL	4,000,000	B	4
183	HAY BALERS	4,000,000	B	3
184	TOBACCO MANUFACTURING MACHINES	4,000,000	B	4
185	FEEDERS	4,000,000	B	4
186	CLAYWORKING MACHINER	4,000,000	C	4
187	CORN AND COTTON CULTIVATORS	4,000,000	B	3
188	HAY CONDITIONERS	4,000,000	B	3
189	FLOTATION MACHINES	4,000,000	B	4
190	OFF-SET LITHOGRAPHIC PRESSES	3,000,000	B	4
191	CORN PLNTRS, LISTERS, POTATO PLNTRS, TRN	3,000,000	B	3
192	FEED GRINDERS	3,000,000	B	3
193	ACCOUNTING MACHINES	3,000,000	C	5
194	FIELD CULTIVATORS	3,000,000	B	3
195	SHOEMAKING MACHINERY	3,000,000	C	4
196	ICE CREAM FREEZERS	3,000,000	C	4
197	COMMERCIAL FLOOR WAXERS	3,000,000	B	5
198	MOLDBOARD PLOWS	3,000,000	B	3
199	WINDROWERS - HAY	3,000,000	B	3
200	SHUTTLE CARS - MINING	3,000,000	B	4
201	VENEER AND PLYWOOD EQUIPMENT	2,000,000	C	4
202	CONCRETE PRODUCT MACHINERY	2,000,000	B	4
203	HAY STACKING ATTACHMENTS	2,000,000	B	3
204	HOT ROLLING MILL MACHINES	2,000,000	C	4
205	LOADING, CUTTING, LONGWALL MINING MACH	2,000,000	B	4
206	AIR-CARRIED TYPE POWER SPRAYER	2,000,000	B	3
207	PLANERS - METAL	2,000,000	C	4
208	RETAIL AND COMMERCIAL SCALES	2,000,000	B	5
209	CLASSIFIERS	2,000,000	B	4
210	FLOUR AND GRAIN MILL MACHINERY	2,000,000	C	4
211	GLASS MAKING MACHINERY	2,000,000	B	4
212	CORN PICKERS	2,000,000	B	3
213	COLD ROLLING MILL MACHINES	2,000,000	C	4
214	CORN SHELLERS	2,000,000	C	3
215	CARDING AND COMBING MACHINES	1,000,000	B	4
216	PEANUT DIGGERS	1,000,000	B	3
217	FOUNDRY MACHINERY	1,000,000	C	4
218	GEAR CUTTING MACHINES	1,000,000	B	4
219	DRILLS - MINING	1,000,000	B	4
220	FRONT AND REAR MOUNTED LOADERS	1,000,000	B	3
221	PULPMILL MACHINERY	1,000,000	B	4
222	CONCRETE MIXERS	1,000,000	B	4
223	BINDERY EQUIPMENT	900,000	B	4
224	LETTERSET PRINTING PRESSES	900,000	B	4
225	MAGNETIC SEPARATORS	800,000	B	4
226	COMMERCIAL CARPET SWEEPERS	800,000	B	5
227	ELECTRONIC CALCULATORS	800,000	B	5
228	CONTINUOUS MINING MACHINES	700,000	B	4
229	GRINDING MILLS	700,000	B	4
230	HAY BALE LOADERS	700,000	B	3
231	HOMOGENIZERS AND PASTEURIZERS	600,000	B	4
232	BUTTER AND CHEESE PROCESSING MACHINERY	600,000	B	4
233	BAKERY MACHINERY	600,000	B	4
234	WET CYCLONES - MINING	500,000	B	4
235	TOBACCO CURERS	500,000	B	3
236	GRAIN DRILLS	500,000	C	3

Table 24 (Cont.) EVAPORATION FROM SURFACE COATINGS: OPTION 4
(Mass of Hydrocarbon Emissions)

237	CENTRIFUGAL DRIERS	500,000	B	4
238	TAPPING MACHINES	500,000	B	4
239	RAKES	500,000	B	3
240	COTTON STRIPPERS	500,000	B	3
241	LAND LEVELERS	400,000	B	3
242	BORING MACHINES	400,000	B	4
243	SUBSOILERS - DEEP TILLAGE	400,000	B	3
244	ELECTRONIC TUBE MANUFACTURING MACHINERY	400,000	C	4
245	CHISEL PLOWS	300,000	B	3
246	SCRUBBERS - MINING	300,000	B	4
247	CONCENTRATING TABLES	300,000	B	4
248	TERRACING AND DITCHING PLOWS	300,000	B	3
249	WINDROWERS OR SWATHERS	300,000	B	3
250	MANURE PUMPS	300,000	B	3
251	BEET HARVESTORS	300,000	B	3
252	POTATO HARVESTORS	300,000	B	3
253	TURKEY WATERERS	300,000	C	3
254	POWER DUSTERS	300,000	B	3
255	MIDDLEBUSTERS AND DISC BEDDERS	200,000	B	3
256	ROTARY DRILLING EQUIPMENT - SURFACE	200,000	B	4
257	FEED MIXERS	200,000	B	3
258	THERMAL DRIERS - MINING	200,000	B	4
259	ROD WEEDERS	200,000	B	3
260	GRAVURE PRINTING PRESSES	100,000	B	4
261	FLEXOGRAPHIC PRINTING PRESSES	100,000	B	4
262	BROACHING MACHINES	90,000	B	4
263	WASHING AND STERILIZING EQUIPMENT	60,000	C	4
264	DISC PLOWS	60,000	B	3
265	BEET, BEAN, AND VEGETABLE CULTIVATORS	60,000	B	3
266	EGG WASHERS	30,000	B	3
267	SHAPERS - METAL	20,000	B	4
268	EGG GRADERS	10,000	B	3

The computer programs used to generate these priority lists are presented in Appendix D. A sample calculation showing the utility of the prioritization model is given in Appendix E.

B. GRAPHICAL REPRESENTATION OF EMISSION RATES

Figure 20 shows the contribution of the ten categories to the total mass of emissions from surface coating operations (excluding automotive and architectural painting). Three categories (i.e., Sheet, Strip, and Coil Coating; Paper and Paperboard Coating; and Fabric Treatment) account for 95% of the total emissions or 1.20×10^9 kg/yr of emissions. Major appliances account for another 2.38% (3.00×10^8 kg/yr), while the remaining six categories together account for 2.46% (3.10×10^8 kg/yr).

Figure 21 is a schematic flow diagram of industrial surface coating excluding automobile painting showing mass emissions for each of the ten product type categories. Figures 22 through 31 are flowcharts exhibiting product types and their mass emissions for each of the ten categories.

C. DATA RELIABILITY TESTS

Data generated in this program were compared with data reported elsewhere in the literature to demonstrate the reliability of the results obtained in this study. These

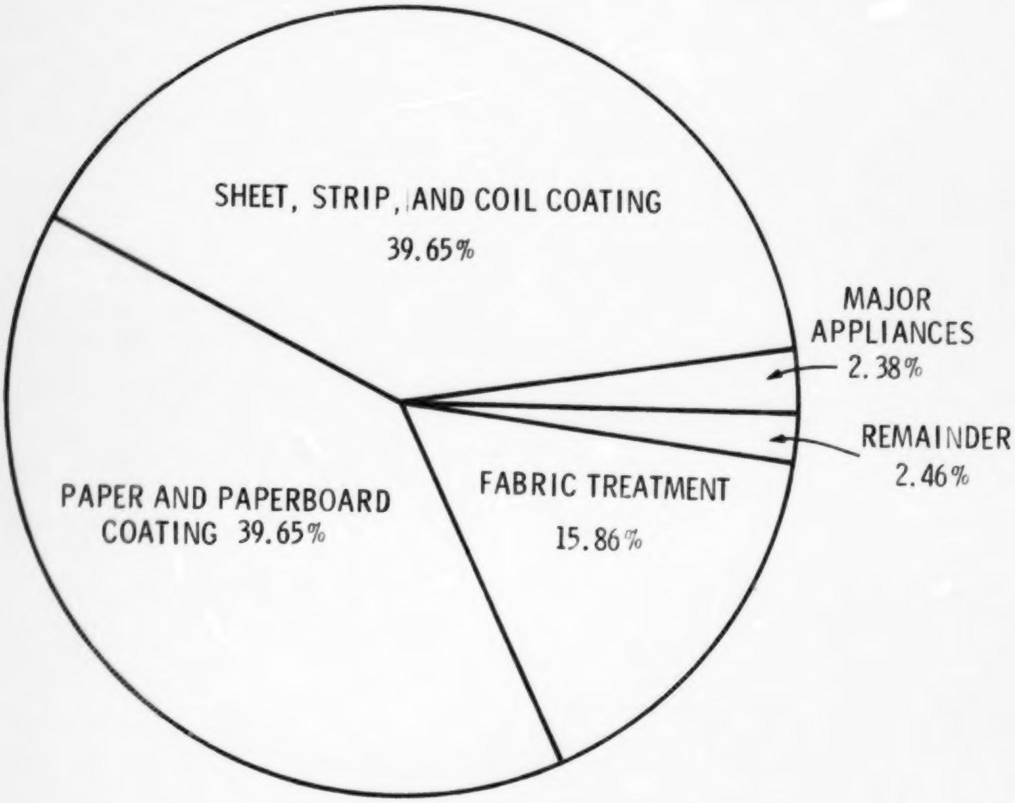

Figure 20. Distribution of mass emissions from industrial surface coating operations excluding automotive painting (total emissions: 1.261×10^9 kg/yr)

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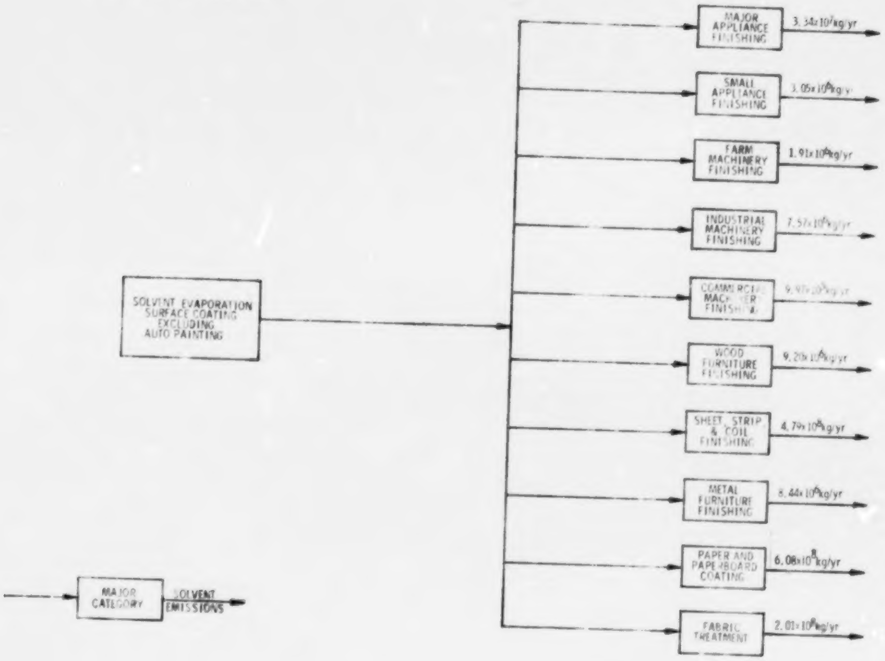
SOLVENT EVAPORATION SURFACE COATING EXCLUDING AUTO PAINTING
MAJOR APPLIANCE FINISHING
3.34×10^7 kg/yr
SMALL APPLIANCE FINISHING
3.05×10^6 kg/yr
FARM MACHINERY FINISHING
1.91×10^6 kg/yr
INDUSTRIAL MACHINERY FINISHING
7.57×10^6 kg/yr
COMMERCIAL MACHINERY FINISHING
9.97×10^5 kg/yr
WOOD FURNITURE FINISHING
9.20×10^6 kg/yr
SHEET, STRIP & COIL FINISHING
4.79×10^6 kg/yr
METAL FURNITURE FINISHING
8.44×10^6 kg/yr
PAPER AND PAPERBOARD COATING
6.08×10^8 kg/yr
FABRIC TREATMENT
2.01×10^8 kg/yr
MAJOR CATEGORY
SOLVENT EMISSIONS

Figure 21. Schematic flow diagram of the emissions from industrial surface coating industry

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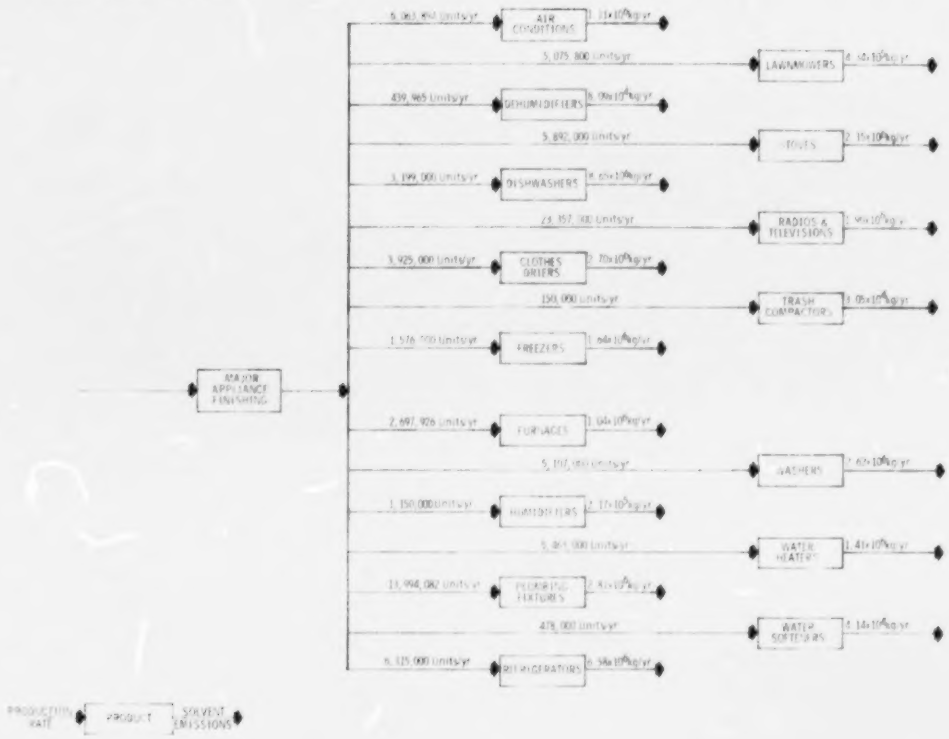
6,063,897 Units/yr
AIR CONDITIONS
1.11×10^{6} kg/yr
5,075,800 Units/yr
LAWNMOWERS
4.50×10^{6} kg/yr
439,965 Units/yr
DEHUMIDIFIERS
8.09×10^{4} kg/yr
5,892,000 Units/yr
STOVES
2.15×10^{6} kg/yr
3,199,000 Units/yr
DISHWASHERS
8.65×10^{6} kg/yr
23,357,300 Units/yr
RADIOS & TELEVISIONS
1.90×10^{6} kg/yr
3,925,000 Units/yr
CLOTHES DRIERS
2.70×10^{6} kg/yr
150,000 Units/yr
TRASH COMPACTORS
3.05×10^{4} kg/yr
1,576,700 Units/yr
FREEZERS
1.64×10^{6} kg/yr
MAJOR APPLIANCE FINISHING
2,697,926 Units/yr
FURNACES
1.64×10^{6} kg/yr
5,197,000 Units/yr
WASHERS
2.62×10^{6} kg/yr
1,150,000 Units/yr
HUMIDIFIERS
2.17×10^{5} kg/yr
5,461,000 Units/yr
WATER HEATERS
1.41×10^{6} kg/yr
13,994,082 Units/yr
PLUMBING FIXTURES
2.81×10^{4} kg/yr
478,000 Units/yr
WATER SOFTENERS
4.14×10^{4} kg/yr
6,125,000 Units/yr
REFRIGERATORS
6.58×10^{6} kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS

Figure 22. Flowchart: major appliance finishing

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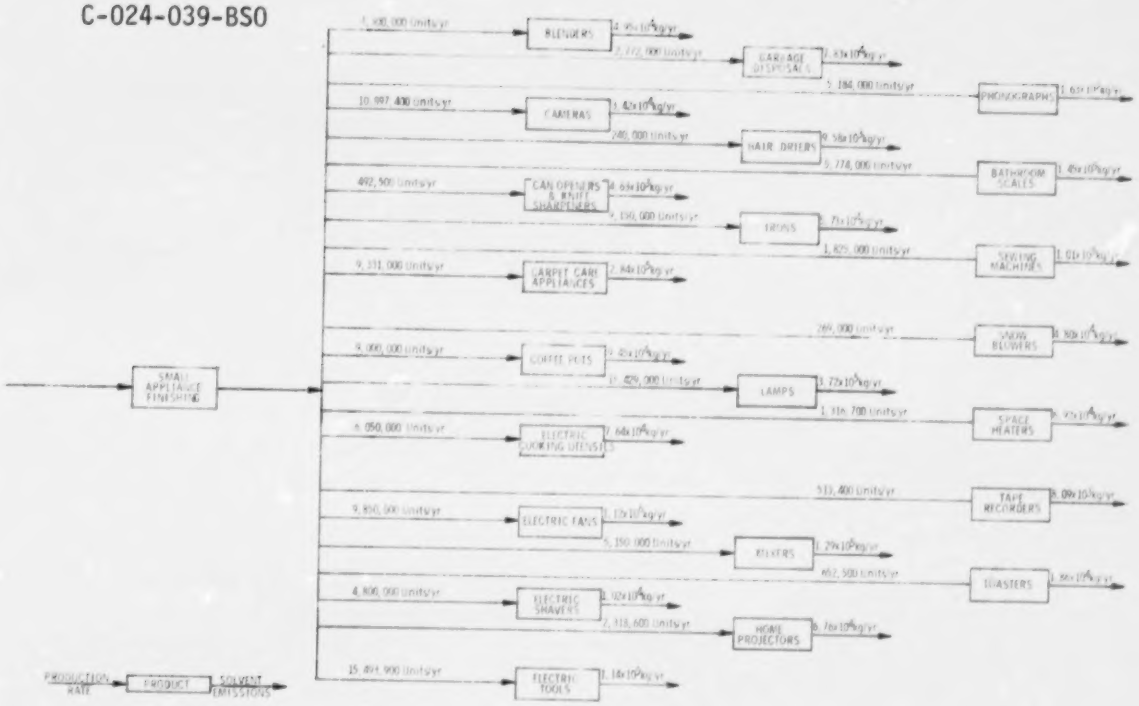
1,300,000 Units/yr
BLENDERS
4.95x10^{4}kg/yr
2,272,000 Units/yr
GARBAGE DISPOSALS
7.83x10^{4}kg/yr
5,184,000 Units/yr
PHONOGRAPHS
1.65x10^{5}kg/yr
10,997,400 Units/yr
CAMERAS
3.42x10^{4}kg/yr
240,000 Units/yr
HAIR DRIERS
9.58x10^{3}kg/yr
5,774,000 Units/yr
BATHROOM SCALES
1.45x10^{5}kg/yr
492,500 Units/yr
CAN OPENERS & KNIFE SHARPENERS
4.63x10^{3}kg/yr
9,150,000 Units/yr
IRONS
2.73x10^{5}kg/yr
1,825,000 Units/yr
SEWING MACHINES
1.01x10^{5}kg/yr
9,331,000 Units/yr
CARPET CARE APPLIANCES
2.84x10^{5}kg/yr
269,000 Units/yr
SNOW BLOWERS
4.30x10^{4}kg/yr
9,000,000 Units/yr
COFFEE POTS
9.45x10^{4}kg/yr
SMALL APPLIANCE FINISHING
17,429,000 Units/yr
LAMPS
3.72x10^{5}kg/yr
1,316,700 Units/yr
SPACE HEATERS
[illegible]x10^{4}kg/yr
6,050,000 Units/yr
ELECTRIC COOKING UTENSILS
7.64x10^{4}kg/yr
513,400 Units/yr
TAPE RECORDERS
8.09x10^{3}kg/yr
9,850,500 Units/yr
ELECTRIC FANS
1.12x10^{5}kg/yr
5,150,000 Units/yr
MIXERS
1.29x10^{5}kg/yr
662,500 Units/yr
TOASTERS
1.86x10^{4}kg/yr
4,800,000 Units/yr
ELECTRIC SHAVERS
2.02x10^{4}kg/yr
2,318,600 Units/yr
HOME PROJECTORS
6.76x10^{4}kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS
15,494,900 Units/yr
ELECTRIC TOOLS
1.14x10^{5}kg/yr

Figure 23. Flowchart: small appliance finishing

C-024-028-BSO

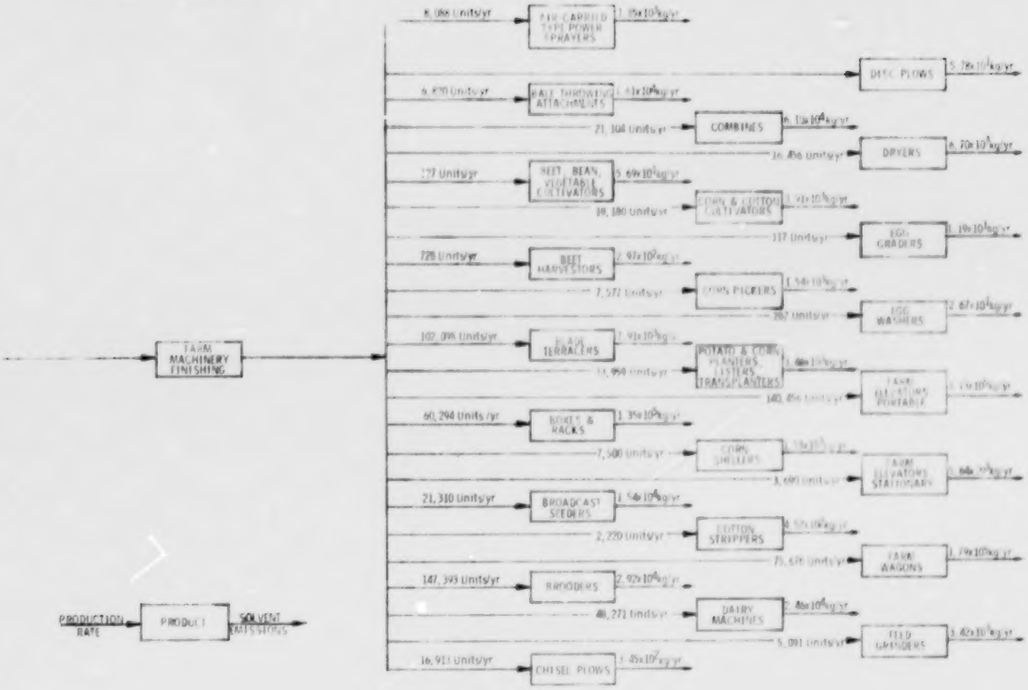
FARM MACHINERY FINISHING
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS
8,086 Units/yr
AIR-CARRIED TYPE POWER SPRAYERS
1.05x10³kg/yr
DISC PLOWS
5.78x10³kg/yr
6,870 Units/yr
BALE THROWING ATTACHMENTS
1.61x10⁴kg/yr
21,104 Units/yr
COMBINES
6.13x10⁴kg/yr
16,456 Units/yr
DRYERS
6.70x10³kg/yr
127 Units/yr
BEET, BEAN, VEGETABLE CULTIVATORS
5.69x10¹kg/yr
18,180 Units/yr
CORN & COTTON CULTIVATORS
3.91x10³kg/yr
117 Units/yr
EGG GRADERS
1.19x10¹kg/yr
728 Units/yr
BEET HARVESTORS
2.97x10²kg/yr
7,577 Units/yr
CORN PICKERS
1.58x10³kg/yr
282 Units/yr
EGG WASHERS
2.67x10¹kg/yr
102,098 Units/yr
BLADE TERRACERS
7.91x10³kg/yr
POTATO & CORN PLANTERS, LISTERS, TRANSPLANTERS
140,456 Units/yr
FARM ELEVATORS PORTABLE
60,294 Units/yr
BOXES & RACKS
1.35x10³kg/yr
7,500 Units/yr
CORN SHELLERS
FARM ELEVATORS STATIONARY
21,310 Units/yr
BROADCAST SEEDERS
1.54x10⁴kg/yr
2,220 Units/yr
COTTON STRIPPERS
75,678 Units/yr
FARM WAGONS
1.79x10³kg/yr
147,393 Units/yr
BROODERS
2.92x10⁴kg/yr
48,271 Units/yr
DAIRY MACHINES
2.86x10⁴kg/yr
5,001 Units/yr
FEED GRINDERS
3.42x10³kg/yr
16,913 Units/yr
CHISEL PLOWS
3.45x10²kg/yr

Figure 24. Flowchart: farm machinery finishing

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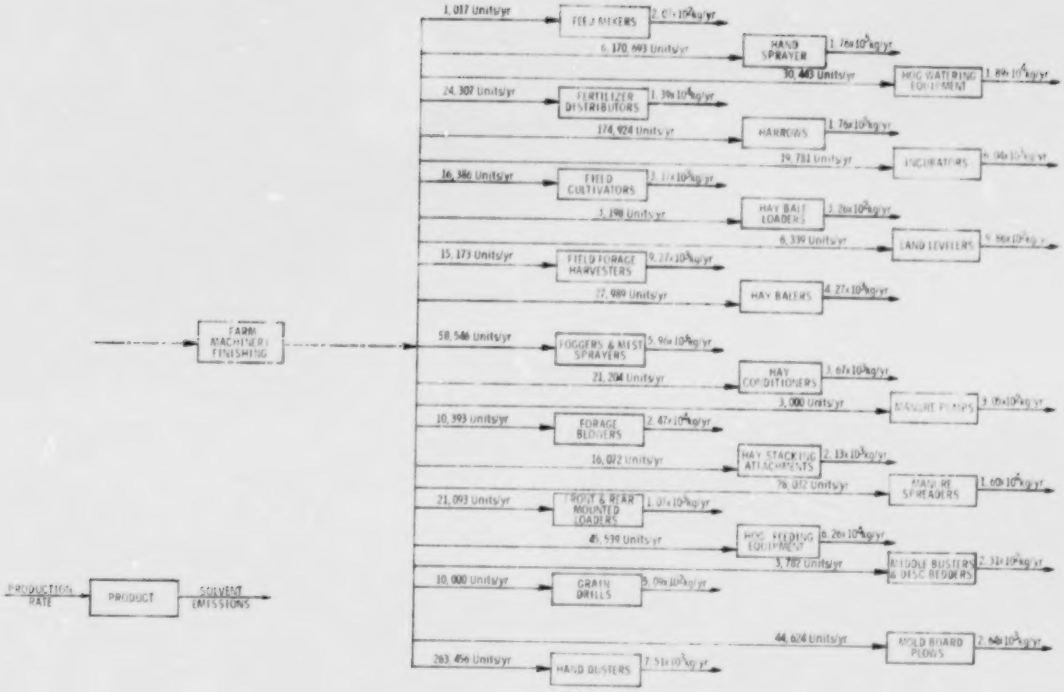
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS
FARM MACHINERY FINISHING
1,017 Units/yr
FEED MIXERS
2.01×10^{2} kg/yr
6,170,693 Units/yr
HAND SPRAYER
1.76×10^{5} kg/yr
30,443 Units/yr
HOG WATERING EQUIPMENT
1.89×10^{4} kg/yr
24,307 Units/yr
FERTILIZER DISTRIBUTORS
1.39×10^{4} kg/yr
174,924 Units/yr
HARROWS
1.76×10^{5} kg/yr
19,781 Units/yr
INCUBATORS
6.94×10^{3} kg/yr
16,386 Units/yr
FIELD CULTIVATORS
3.17×10^{3} kg/yr
3,198 Units/yr
HAY BALE LOADERS
3.26×10^{2} kg/yr
6,339 Units/yr
LAND LEVELERS
9.86×10^{3} kg/yr
15,173 Units/yr
FIELD FORAGE HARVESTERS
9.27×10^{5} kg/yr
27,989 Units/yr
HAY BALERS
4.27×10^{5} kg/yr
58,546 Units/yr
FOGGERS & MIST SPRAYERS
5.96×10^{4} kg/yr
21,204 Units/yr
HAY CONDITIONERS
3.67×10^{3} kg/yr
3,000 Units/yr
MANURE PUMPS
3.05×10^{2} kg/yr
10,393 Units/yr
FORAGE BLOWERS
2.47×10^{4} kg/yr
16,072 Units/yr
HAY STACKING ATTACHMENTS
2.13×10^{3} kg/yr
76,032 Units/yr
MANURE SPREADERS
1.60×10^{4} kg/yr
21,093 Units/yr
FRONT & REAR MOUNTED LOADERS
1.07×10^{5} kg/yr
45,539 Units/yr
HOG FEEDING EQUIPMENT
6.26×10^{4} kg/yr
3,782 Units/yr
MIDDLE BUSTERS & DISC BEDDERS
2.31×10^{2} kg/yr
10,000 Units/yr
GRAIN DRILLS
5.09×10^{2} kg/yr
44,624 Units/yr
MOLD BOARD PLOWS
2.64×10^{5} kg/yr
263,456 Units/yr
HAND DUSTERS
7.51×10^{3} kg/yr

Figure 24. (Cont.) Flowchart: farm machinery finishing

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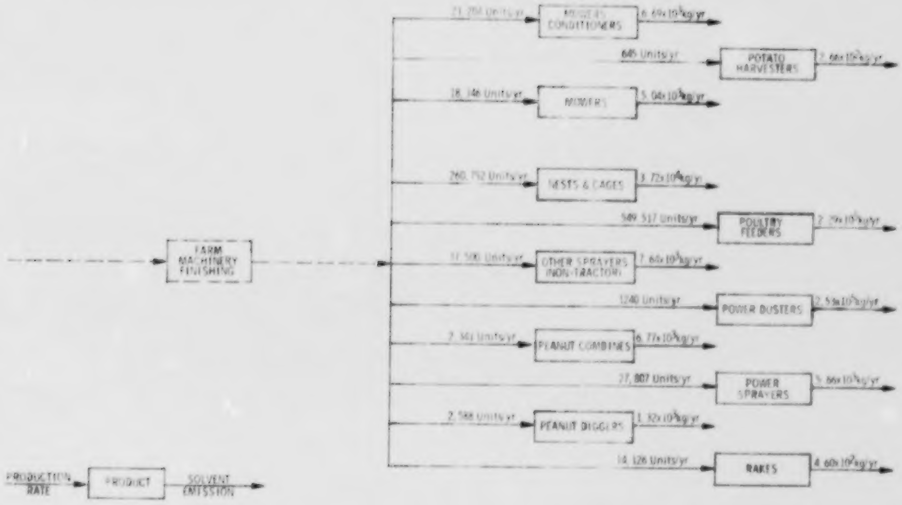
21,754 Units/yr
MOWERS CONDITIONERS
6.69×10^3 kg/yr
645 Units/yr
POTATO HARVESTERS
2.66×10^2 kg/yr
18,146 Units/yr
MOWERS
5.04×10^3 kg/yr
260,752 Units/yr
NESTS & CAGES
3.72×10^4 kg/yr
589,517 Units/yr
POULTRY FEEDERS
2.29×10^5 kg/yr
FARM MACHINERY FINISHING
17,500 Units/yr
OTHER SPRAYERS (NON-TRACTOR)
7.64×10^3 kg/yr
1240 Units/yr
POWER DUSTERS
2.53×10^2 kg/yr
2,341 Units/yr
PEANUT COMBINES
6.77×10^3 kg/yr
27,807 Units/yr
POWER SPRAYERS
5.86×10^3 kg/yr
2,588 Units/yr
PEANUT DIGGERS
1.32×10^3 kg/yr
14,128 Units/yr
RAKES
4.60×10^2 kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSION

Figure 24. (Cont.) Flowchart: farm machinery finishing

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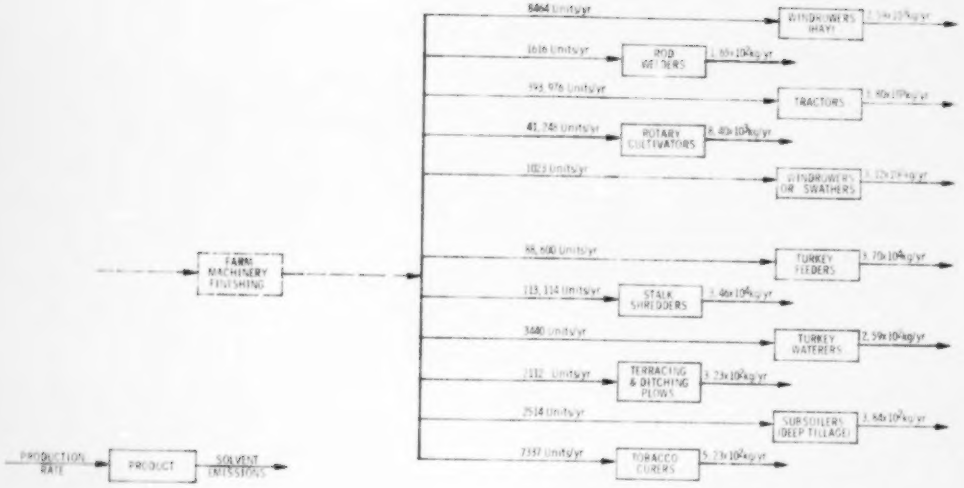

FARM MACHINERY FINISHING
8464 Units/yr
WINDROWERS (HAY)
1616 Units/yr
ROD WEEDERS
1.65x10^2 kg/yr
393,976 Units/yr
TRACTORS
41,748 Units/yr
ROTARY CULTIVATORS
8.40x10^3 kg/yr
1023 Units/yr
WINDROWERS OR SWATHERS
88,600 Units/yr
TURKEY FEEDERS
3.70x10^4 kg/yr
113,114 Units/yr
STALK SHREDDERS
3.46x10^4 kg/yr
3440 Units/yr
TURKEY WATERERS
2.59x10^2 kg/yr
2112 Units/yr
TERRACING & DITCHING PLOWS
3.23x10^2 kg/yr
2514 Units/yr
SUBSOILERS (DEEP TILLAGE)
3.84x10^2 kg/yr
7337 Units/yr
TOBACCO CURERS
5.23x10^2 kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS

Figure 24. (Cont.) Flowchart: farm machinery finishing

C-024-029-BSO

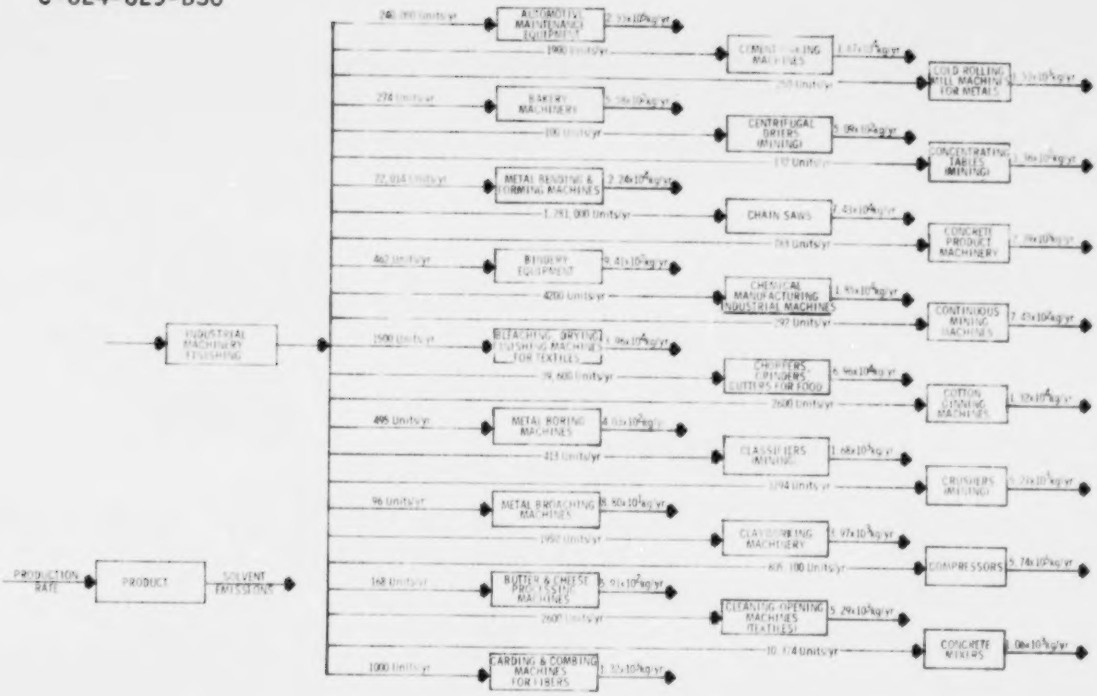

PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS
INDUSTRIAL MACHINERY FINISHING
246,000 Units/yr
AUTOMOTIVE MAINTENANCE EQUIPMENT
1900 Units/yr
CEMENT MAKING MACHINES
1.47x10^4kg/yr
250 Units/yr
COLD ROLLING MILL MACHINES FOR METALS
1.53x10^3kg/yr
274 Units/yr
BAKERY MACHINERY
5.58x10^2kg/yr
100 Units/yr
CENTRIFUGAL DRIERS (MINING)
5.09x10^2kg/yr
117 Units/yr
CONCENTRATING TABLES (MINING)
1.96x10^3kg/yr
72,014 Units/yr
METAL BENDING & FORMING MACHINES
2.24x10^4kg/yr
1,291,000 Units/yr
CHAIN SAWS
7.43x10^4kg/yr
733 Units/yr
CONCRETE PRODUCT MACHINERY
462 Units/yr
BINDERY EQUIPMENT
9.41x10^2kg/yr
4200 Units/yr
CHEMICAL MANUFACTURING INDUSTRIAL MACHINES
1.95x10^4kg/yr
292 Units/yr
CONTINUOUS MINING MACHINES
7.43x10^2kg/yr
1500 Units/yr
BLEACHING, DRYING, FINISHING MACHINES FOR TEXTILES
1.96x10^4kg/yr
39,600 Units/yr
CHOPPERS, GRINDERS, CUTTERS FOR FOOD
6.96x10^4kg/yr
2600 Units/yr
COTTON GINNING MACHINES
1.32x10^4kg/yr
495 Units/yr
METAL BORING MACHINES
4.03x10^2kg/yr
413 Units/yr
CLASSIFIERS (MINING)
1.68x10^3kg/yr
1294 Units/yr
CRUSHERS (MINING)
5.21x10^3kg/yr
96 Units/yr
METAL BROACHING MACHINES
8.60x10^1kg/yr
1992 Units/yr
CLAYWORKING MACHINERY
3.97x10^3kg/yr
805,100 Units/yr
COMPRESSORS
5.74x10^2kg/yr
168 Units/yr
BUTTER & CHEESE PROCESSING MACHINES
5.91x10^2kg/yr
2600 Units/yr
CLEANING OPENING MACHINES (TEXTILES)
5.29x10^3kg/yr
10,174 Units/yr
CONCRETE MIXERS
1.08x10^5kg/yr
1000 Units/yr
CARDING & COMBING MACHINES FOR FIBERS
1.35x10^3kg/yr

Figure 25. Flowchart: industrial machinery finishing

C-024-029-BSO

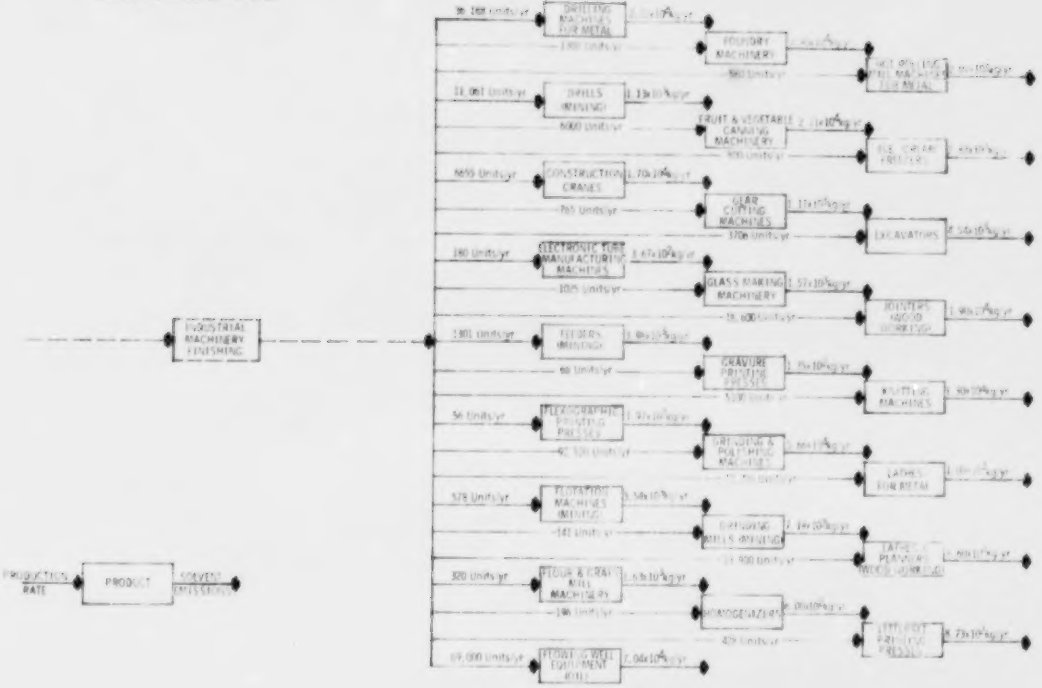

INDUSTRIAL MACHINERY FINISHING
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS
DRILLING MACHINES FOR METAL
FOUNDRY MACHINERY
DRILLS (MINING)
11,061 Units/yr
6000 Units/yr
FRUIT & VEGETABLE CANNING MACHINERY
ICE CREAM FREEZERS
5655 Units/yr
CONSTRUCTION CRANES
765 Units/yr
GEAR CUTTING MACHINES
EXCAVATORS
180 Units/yr
ELECTRONIC TUBE MANUFACTURING MACHINES
1005 Units/yr
GLASS MAKING MACHINERY
JOINTERS (WOOD WORKING)
1301 Units/yr
FEEDERS (MINING)
GRAVURE PRINTING PRESSES
KNITTING MACHINES
56 Units/yr
FLEXOGRAPHIC PRINTING PRESSES
GRINDING & POLISHING MACHINES
LATHES FOR METAL
578 Units/yr
FLOTATION MACHINES (MINING)
141 Units/yr
GRINDING MILLS (MINING)
LATHES & PLANERS (WOOD WORKING)
320 Units/yr
FLOUR & GRAIN MILL MACHINERY
HOMOGENIZERS
LETTERPRESS PRINTING PRESSES
FLOWING WELL EQUIPMENT (OIL)

Figure 25. (Cont.) Flowchart: industrial machinery finishing

C-024-029-BSO

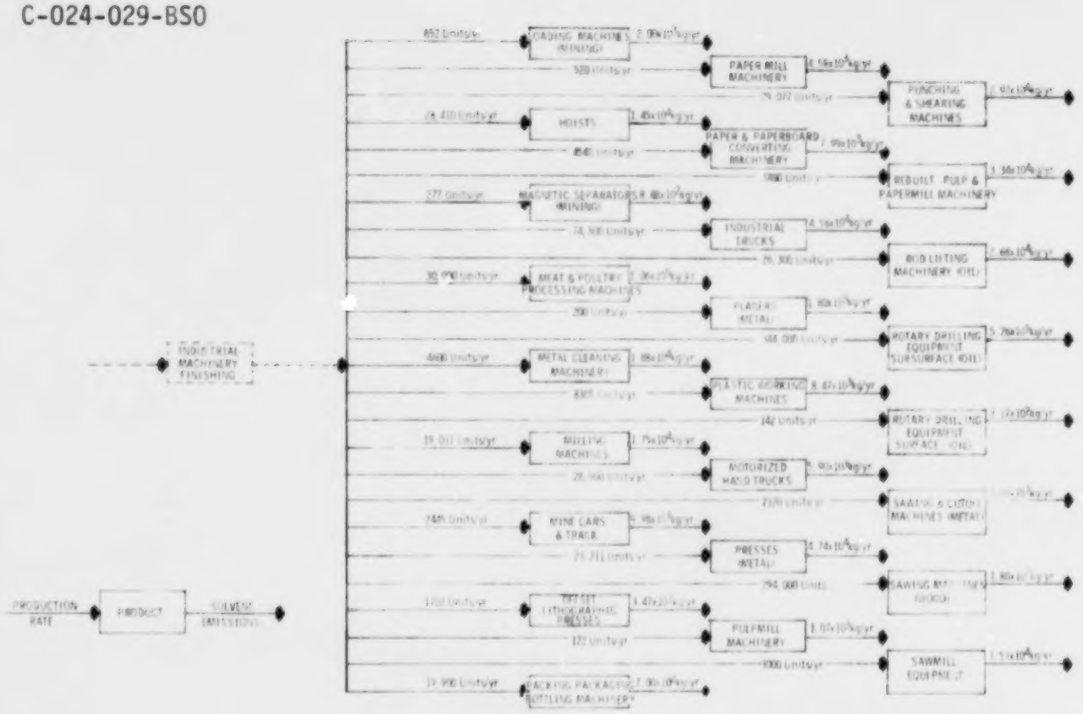

PRODUCTION RATE
PRODUCT
SOLVENT EMISSION
INDUSTRIAL MACHINERY FINISHING
852 Units/yr
LOADING MACHINES (MINING)
2.99x10³kg/yr
520 Units/yr
PAPER MILL MACHINERY
4.59x10³kg/yr
29,077 Units/yr
PUNCHING & SHEARING MACHINES
2.97x10⁴kg/yr
28,410 Units/yr
HOISTS
1.45x10⁴kg/yr
4840 Units/yr
PAPER & PAPERBOARD CONVERTING MACHINERY
7.99x10³kg/yr
1880 Units/yr
REBUILT PULP & PAPERMILL MACHINERY
1.34x10⁴kg/yr
277 Units/yr
MAGNETIC SEPARATORS (MINING)
8.46x10²kg/yr
74,900 Units/yr
INDUSTRIAL TRUCKS
4.59x10⁴kg/yr
26,300 Units/yr
ROD LIFTING MACHINERY (OIL)
7.66x10⁴kg/yr
30,990 Units/yr
MEAT & POULTRY PROCESSING MACHINES
2.26x10³kg/yr
200 Units/yr
PLANERS (METAL)
1.80x10³kg/yr
144,000 Units/yr
ROTARY DRILLING EQUIPMENT SUBSURFACE (OIL)
5.78x10³kg/yr
4400 Units/yr
METAL CLEANING MACHINERY
1.89x10⁴kg/yr
8305 Units/yr
PLASTIC WORKING MACHINES
8.47x10³kg/yr
142 Units/yr
ROTARY DRILLING EQUIPMENT SURFACE (OIL)
1.17x10²kg/yr
19,011 Units/yr
MILLING MACHINES
1.75x10⁴kg/yr
28,760 Units/yr
MOTORIZED HAND TRUCKS
5.90x10⁴kg/yr
SAWING & CUTOFF MACHINES (METAL)
2485 Units/yr
MINE CARS & TRACK
5.98x10³kg/yr
21,211 Units/yr
PRESSES (METAL)
4.74x10⁴kg/yr
294,000 Units
SAWING MACHINES (WOOD)
1.80x10³kg/yr
1700 Units/yr
OFFSET LITHOGRAPHIC PRESSES
3.47x10³kg/yr
122 Units/yr
PULPMILL MACHINERY
1.07x10³kg/yr
9000 Units/yr
SAWMILL EQUIPMENT
1.51x10⁴kg/yr
19,900 Units/yr
PACKING PACKAGING BOTTLING MACHINERY
7.00x10³kg/yr

Figure 25. (Cont.) Flowchart: industrial machinery finishing

C-024-024-BSO

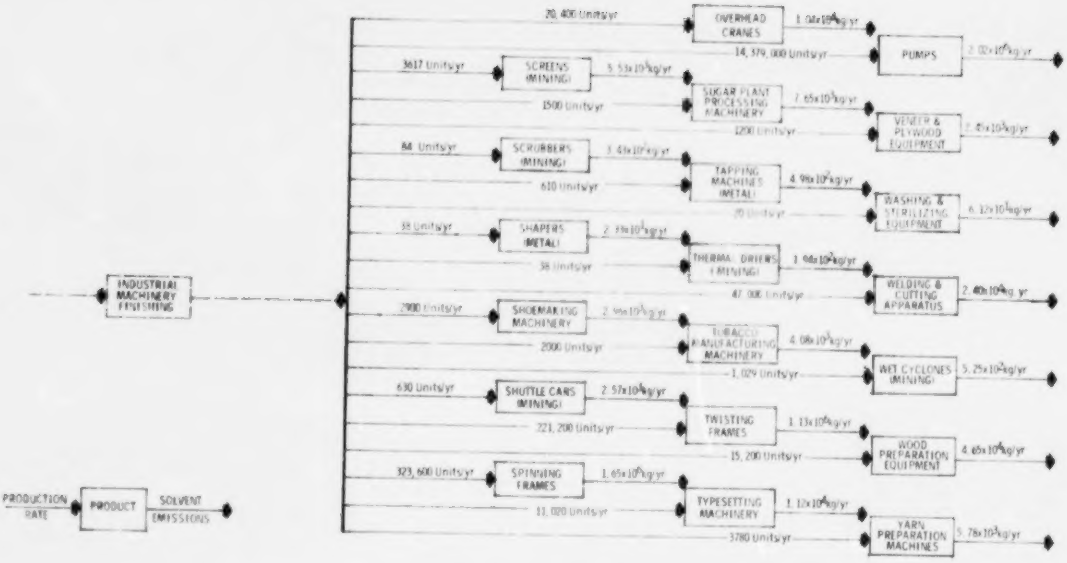

INDUSTRIAL MACHINERY FINISHING
20,400 Units/yr
OVERHEAD CRANES
1.04×10^{4} kg/yr
14,379,000 Units/yr
PUMPS
2.02×10^{6} kg/yr
3617 Units/yr
SCREENS (MINING)
5.53×10^{3} kg/yr
1500 Units/yr
SUGAR PLANT PROCESSING MACHINERY
7.65×10^{3} kg/yr
1200 Units/yr
VENEER & PLYWOOD EQUIPMENT
2.45×10^{3} kg/yr
84 Units/yr
SCRUBBERS (MINING)
3.43×10^{2} kg/yr
610 Units/yr
TAPPING MACHINES (METAL)
4.98×10^{2} kg/yr
20 Units/yr
WASHING & STERILIZING EQUIPMENT
6.12×10^{1} kg/yr
38 Units/yr
SHAPERS (METAL)
2.33×10^{1} kg/yr
38 Units/yr
THERMAL DRIERS (MINING)
1.94×10^{2} kg/yr
47,000 Units/yr
WELDING & CUTTING APPARATUS
2.40×10^{4} kg yr
2900 Units/yr
SHOEMAKING MACHINERY
2.95×10^{3} kg/yr
2000 Units/yr
TOBACCO MANUFACTURING MACHINERY
4.08×10^{3} kg/yr
1,029 Units/yr
WET CYCLONES (MINING)
5.25×10^{2} kg/yr
630 Units/yr
SHUTTLE CARS (MINING)
2.57×10^{4} kg/yr
221,200 Units/yr
TWISTING FRAMES
1.13×10^{4} kg/yr
15,200 Units/yr
WOOD PREPARATION EQUIPMENT
4.65×10^{4} kg/yr
323,600 Units/yr
SPINNING FRAMES
1.65×10^{4} kg/yr
11,020 Units/yr
TYPESETTING MACHINERY
1.12×10^{4} kg/yr
3780 Units/yr
YARN PREPARATION MACHINES
5.78×10^{3} kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS

Figure 25. (Cont.) Flowchart: industrial machinery finishing

C-024-030-BSO

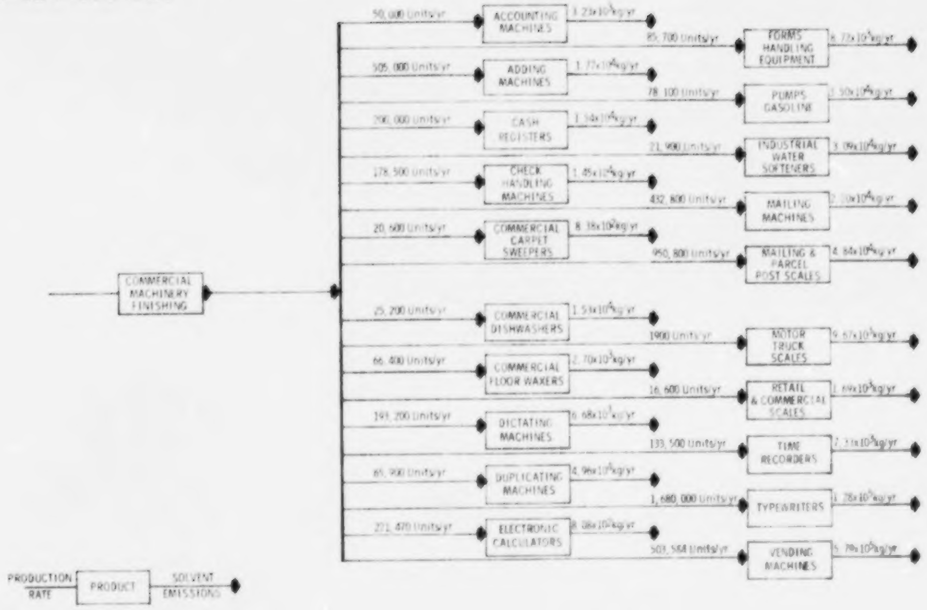

COMMERCIAL MACHINERY FINISHING
50,000 Units/yr
ACCOUNTING MACHINES
3.23x10^{3}kg/yr
85,700 Units/yr
FORMS HANDLING EQUIPMENT
6.72x10^{3}kg/yr
505,000 Units/yr
ADDING MACHINES
1.77x10^{4}kg/yr
78,100 Units/yr
PUMPS GASOLINE
1.50x10^{4}kg/yr
290,000 Units/yr
CASH REGISTERS
1.34x10^{4}kg/yr
21,900 Units/yr
INDUSTRIAL WATER SOFTENERS
3.09x10^{4}kg/yr
178,500 Units/yr
CHECK HANDLING MACHINES
1.45x10^{4}kg/yr
432,800 Units/yr
MAILING MACHINES
2.10x10^{4}kg/yr
20,600 Units/yr
COMMERCIAL CARPET SWEEPERS
8.38x10^{2}kg/yr
950,800 Units/yr
MAILING & PARCEL POST SCALES
4.84x10^{4}kg/yr
25,200 Units/yr
COMMERCIAL DISHWASHERS
1.53x10^{4}kg/yr
1900 Units/yr
MOTOR TRUCK SCALES
9.67x10^{3}kg/yr
66,400 Units/yr
COMMERCIAL FLOOR WAXERS
2.70x10^{3}kg/yr
16,600 Units/yr
RETAIL & COMMERCIAL SCALES
1.69x10^{3}kg/yr
191,200 Units/yr
DICTATING MACHINES
6.68x10^{3}kg/yr
133,500 Units/yr
TIME RECORDERS
7.31x10^{3}kg/yr
85,900 Units/yr
DUPLICATING MACHINES
4.96x10^{3}kg/yr
1,680,000 Units/yr
TYPEWRITERS
1.78x10^{5}kg/yr
221,470 Units/yr
ELECTRONIC CALCULATORS
8.08x10^{2}kg/yr
503,564 Units/yr
VENDING MACHINES
5.79x10^{5}kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS

Figure 26. Flowchart: commercial machinery finishing

C-024-035-BSO

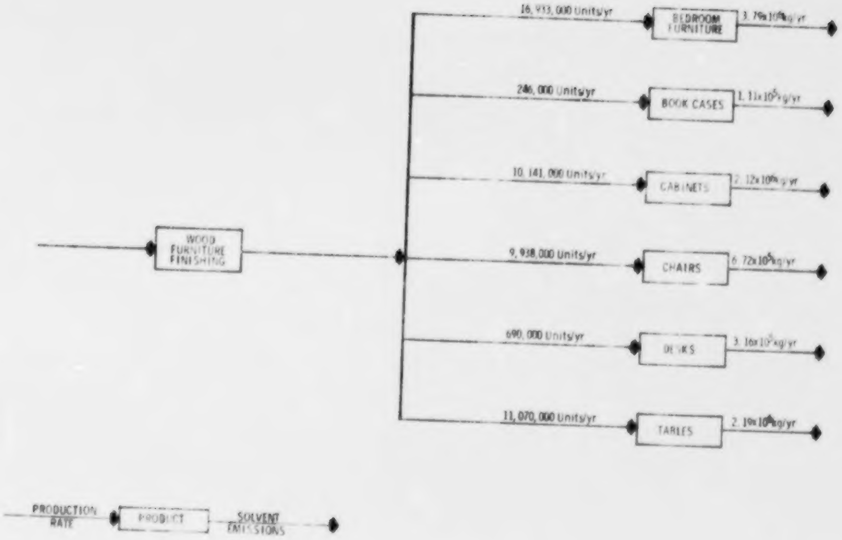

WOOD FURNITURE FINISHING
16,933,000 Units/yr
BEDROOM FURNITURE
3.79x10⁶kg/yr
246,000 Units/yr
BOOK CASES
1.11x10⁵kg/yr
10,141,000 Units/yr
CABINETS
2.12x10⁶kg/yr
9,938,000 Units/yr
CHAIRS
6.72x10⁵kg/yr
690,000 Units/yr
DESKS
3.16x10⁵kg/yr
11,070,000 Units/yr
TABLES
2.19x10⁶kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS

Figure 27. Flowchart: wood furniture finishing

C-024-033-BSO

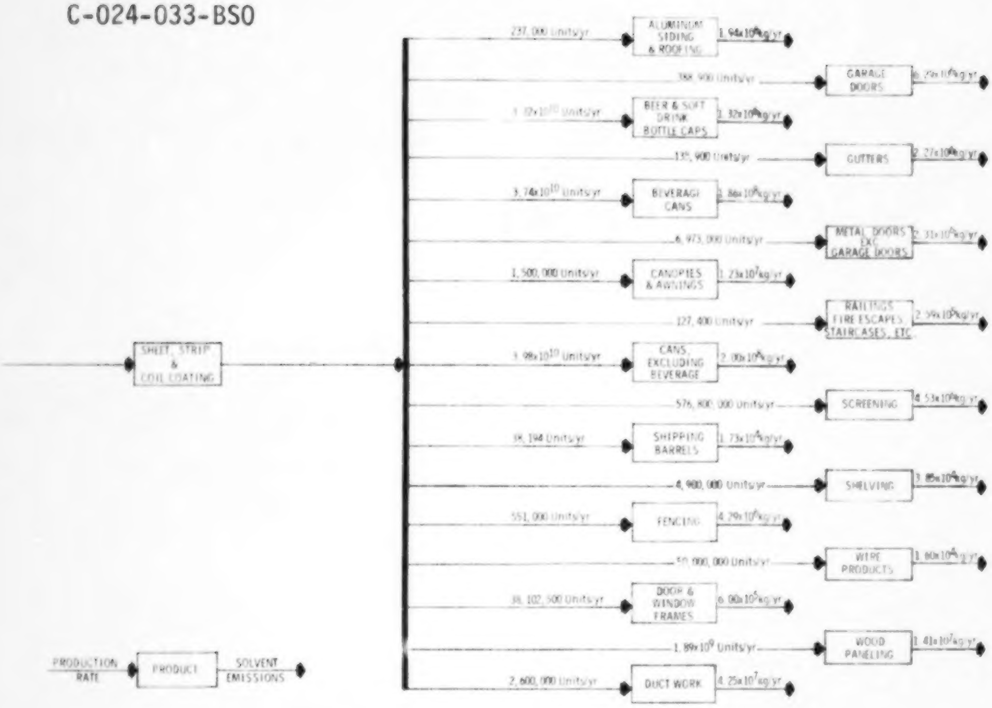

237,000 Units/yr
ALUMINUM SIDING & ROOFING
1.94x10⁶kg/yr
388,900 Units/yr
GARAGE DOORS
6.29x10⁶kg/yr
1.32x10¹⁰ Units/yr
BEER & SOFT DRINK BOTTLE CAPS
1.32x10⁶kg/yr
135,900 Units/yr
GUTTERS
2.27x10⁶kg/yr
3.74x10¹⁰ Units/yr
BEVERAGE CANS
1.86x10⁸kg/yr
6,973,000 Units/yr
METAL DOORS EXC GARAGE DOORS
2.31x10⁶kg/yr
1,500,000 Units/yr
CANOPIES & AWNINGS
1.23x10⁷kg/yr
127,400 Units/yr
RAILINGS FIRE ESCAPES STAIRCASES, ETC
2.59x10⁵kg/yr
SHEET, STRIP & COIL COATING
3.98x10¹⁰ Units/yr
CANS, EXCLUDING BEVERAGE
2.00x10⁸kg/yr
576,800,000 Units/yr
SCREENING
4.53x10⁶kg/yr
38,194 Units/yr
SHIPPING BARRELS
1.73x10⁴kg/yr
4,900,000 Units/yr
SHELVING
3.85x10⁶kg/yr
551,000 Units/yr
FENCING
4.29x10⁶kg/yr
50,000,000 Units/yr
WIRE PRODUCTS
1.80x10⁶kg/yr
38,102,500 Units/yr
DOOR & WINDOW FRAMES
6.00x10⁵kg/yr
1.89x10⁹ Units/yr
WOOD PANELING
1.41x10⁷kg/yr
2,600,000 Units/yr
DUCT WORK
4.25x10⁷kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS

Figure 28. Flowchart: sheet, strip, and coil coating

C-024-034-BSO

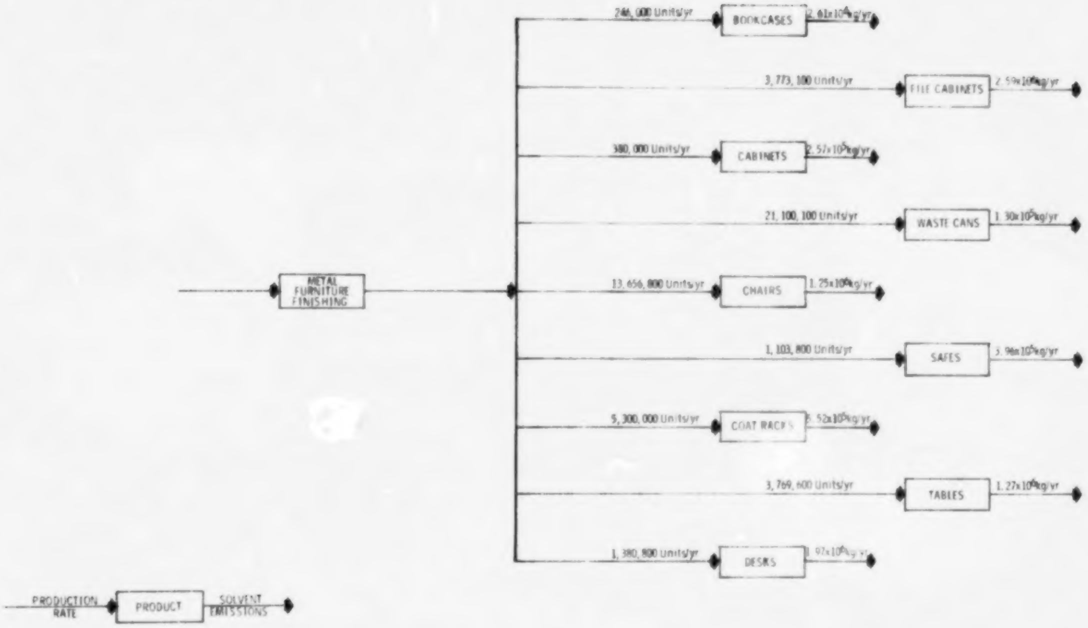
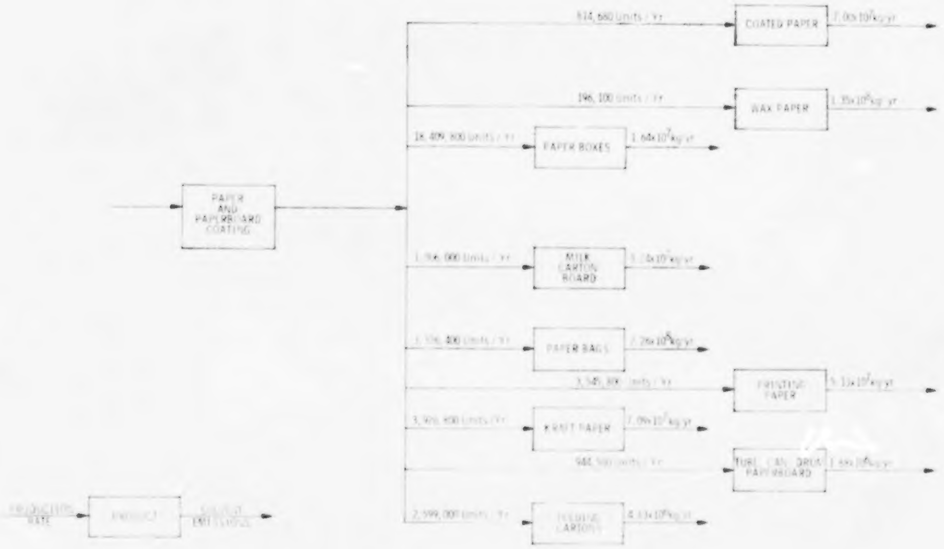

METAL FURNITURE FINISHING
246,000 Units/yr
BOOKCASES
2.61x10^4 kg/yr
3,773,100 Units/yr
FILE CABINETS
2.59x10^6 kg/yr
380,000 Units/yr
CABINETS
2.57x10^5 kg/yr
21,100,100 Units/yr
WASTE CANS
1.30x10^5 kg/yr
13,656,800 Units/yr
CHAIRS
1.25x10^6 kg/yr
1,103,800 Units/yr
SAFES
3.96x10^5 kg/yr
5,300,000 Units/yr
COAT RACKS
5.52x10^5 kg/yr
3,769,600 Units/yr
TABLES
1.27x10^6 kg/yr
1,380,800 Units/yr
DESKS
1.97x10^6 kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS

Figure 29. Flowchart: metal furniture finishing

C-024-031-BSO



PAPER AND PAPERBOARD COATING
614,680 Units / Yr
COATED PAPER
7.00×10^7 kg/yr
196,100 Units / Yr
WAX PAPER
1.35×10^8 kg/yr
18,409,800 Units / Yr
PAPER BOXES
1.64×10^7 kg/yr
1,396,000 Units / Yr
MILK CARTON BOARD
3.24×10^7 kg/yr
1,376,400 Units / Yr
PAPER BAGS
7.26×10^8 kg/yr
3,545,800 Units / Yr
PRINTING PAPER
5.13×10^7 kg/yr
3,926,400 Units / Yr
KRAFT PAPER
7.09×10^7 kg/yr
944,500 Units / Yr
TUBE, CAN, DRUM PAPERBOARD
1.46×10^8 kg/yr
2,599,000 Units / Yr
FOLDING CARTONS
4.13×10^8 kg/yr
PRODUCTION RATE
PRODUCT
SOLVENT EMISSIONS

Figure 30. Flowchart: paper and paperboard coating

C-024-032-BSO

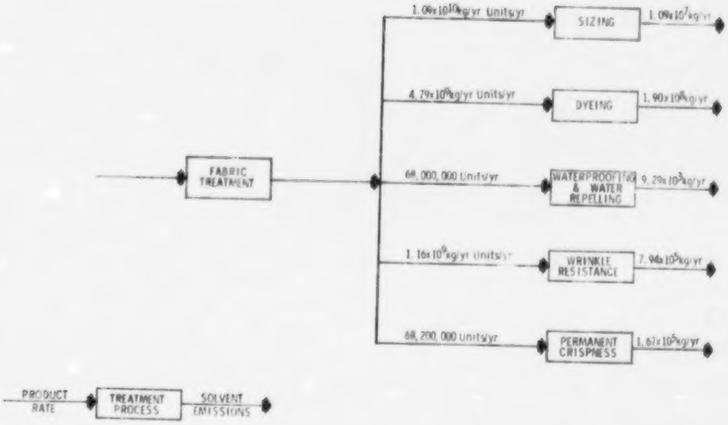

1.09×10^{10} kg/yr Units/yr
SIZING
1.09×10^{7} kg/yr
4.79×10^{9} kg/yr Units/yr
DYEING
1.90×10^{8} kg/yr
FABRIC TREATMENT
68, 000, 000 Units/yr
WATERPROOFING & WATER REPELLING
9.29×10^{3} kg/yr
1.16×10^{9} kg/yr Units/yr
WRINKLE RESISTANCE
7.94×10^{5} kg/yr
68, 200, 000 Units/yr
PERMANENT CRISPNESS
1.67×10^{5} kg/yr
PRODUCT RATE
TREATMENT PROCESS
SOLVENT EMISSIONS

Figure 31. Flowchart: fabric treatment

comparisons are summarized below:

- The total mass of emissions for solvent evaporation from painting operations (product type categories 1-8) obtained in this study is 5.61 x 10^8 kg/year. Literature values for corresponding industrial surface coating excluding automotive painting vary from 3.6 x 10^8 to 9.1 x 10^8 kg/year.[10,65,66,67]

- The emission rate obtained for solvent evaporation from major appliance refinishing (product type category 1) is 3.0 x 10^7 kg/year. The value published in the literature is 2.8 x 10^7 kg/year.[68]

- The emission factor for coil coating operations has been reported in the German literature as 70 to 85 grams per square meter of surface covered.[69] The values obtained in this study are presented in Table 25. The average of these values is 77±13 g/m^2.

- The literature reports that the emission factor for painting operations is 582±137 kg/1000 kg of paint applied.[70] The average value obtained in this study is 534 kg/1000 kg.

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[65] Cavender, J. H., Kircher, D. S., and Hoffman, A. J., Nationwide Air Pollutant Emission Trends, 1940-1970, January, 1973.

[66] Anon., The Paint Industry, Chemical and Engineering News, December 20, 1969, pp. 32-43.

[67] Yazujian, "Chemicals in Coatings," Chemical Week, October 20, 1971, pp. 35-44.

[68] Hydrocarbon Pollutant Systems Study, Vol. I, Stationary Sources, Effects and Control, MSA Research Corporation, October, 1972, PB-219 073.

[69] Menthen, B., Waste Air Problems in the Coil Coating Industry, Staub-reinholt Luft, Vol. 31, No. 10, October 1971, pp. 16-21.

[70] Compilation of Air Pollutant Emission Factors, AP-42, Second Edition, April, 1973.

Table 25. SUMMARY OF EMISSION FACTORS FOR SHEET, STRIP, AND COIL COATING OPERATIONS

Product	Surface covered, 10^7 m^2/yr	Emission rate, 10^9 g/yr	Emission factor, g/m^2
Aluminum siding and roofing	2.5	2	80
Beer and soft drink bottle caps	1.7	1	59
Beverage cans	241	200	83
Canopies and awnings	15.8	10	63
Door and window frames	0.7	0.6	86
Ductwork	54.6	40	73
Fencing	5.5	4	73
Garage doors	0.8	0.6	75
Gutters	2.9	2	69
Metal cans (excluding beverage cans)	257	200	78
Metal doors (excluding garage doors)	2.9	2	69
Railings, fire escapes, staircases	0.3	0.3	100
Screening	5.4	5	93
Shelving	0.05	0.04	80
Steel shipping barrels	0.03	0.02	67
Wire products	0.02	0.02	100
Wood paneling	16.7	10	60

D. SENSITIVITY ANALYSIS

The impact factor is directly proportional to the production rate, emission factor, and location (i.e., population density); the error in the impact factor is directly proportional to the error in each of these data. For instance, a 10% error in the population densities of each of the states used to calculate an impact factor results in a 10% error in that impact factor. Since the impact factor is inversely proportional to the square of the emission height, a decrease of 10% in the height will result in an increase of 23% in the final impact factor.

The emission rate for each product is directly proportional to both the production rate and emission factor. Thus, a 10% error in either production rate or emission factor results in a 10% error in the impact factor.

SECTION VI

CONTROL TECHNOLOGY

A. STATE OF THE ART

1. Adsorption

Adsorption is the process for removing molecules from a fluid by contacting them with a solid. Gases, liquids, or solids can be selectively removed from airstreams with materials known as adsorbents. The material which adheres to the adsorbent is called the adsorbate.

The mechanism by which components are adsorbed is complex, and although adsorption occurs at all solid interfaces, it is small unless the adsorbent has a large surface area, is porous, and possesses capillaries. The important characteristics of solid adsorbents are their large surface-to-volume ratios and preferential affinity for individual components.

The adsorption process includes three steps. The adsorbent is first contacted with the fluid, and a separation by adsorption results. Second, the unadsorbed portion of the fluid is separated from the adsorbent. For gases, this operation is completed when the gases leave the adsorbent bed. Third, the adsorbent is regenerated by removing the

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adsorbate from the adsorbent. For solvent recovery, low pressure steam is used to regenerate the adsorbent, and the condensed vapors are separated from the water by decantation, distillation, or both.

Activated carbon is capable of adsorbing 95% to 98% of the organic vapor from air at ambient temperature in the presence of water in the gas stream.[6 8] Because the adsorbed compounds have low vapor pressure at ambient temperatures, the recovery of solvents present in air in small concentrations is low. The adsorption system can be operated without hazard because the vapor concentration is below the flammable range.

When a solvent vapor in air mixture is passed over activated carbon, adsorption of the solvent vapor takes place. Adsorption is complete at the beginning, but as the adsorptive capacity of the activated carbon is approached, traces of vapor appear in the exit air. When this situation occurs, it is said that the breakpoint of the activated carbon has been reached. As the air flow is continued, and although additional amounts of solvent are adsorbed, the concentration of solvent vapor increases until the concentration of vapor in the exit air equals the vapor concentration in the inlet air. The adsorbent is saturated under these operating conditions.

The adsorption of a mixture of adsorbable organic vapors in air is not uniform, and the more easily adsorbed components are those which have higher boiling points. When air containing a mixture of organic vapors is passed over activated carbon, the vapors are equally adsorbed at the start. However, as the amount of the higher boiling component in the adsorbent increases, the more volatile component revaporizes. The exit vapor consists primarily of the more volatile component after the breakpoint has been reached. This process continues for each organic mixture component, until the highest boiling component is present in the exit gas. In the control of organic vapor mixtures, the adsorption cycle should be stopped when the first breakpoint occurs as determined by detection of vapors in the exit gas. Many theories have been advanced to explain the selective adsorption of certain vapors or gases. These theories are discussed by Perry and Chilton[71] and will not be discussed here.

The quantity of organic vapors adsorbed by activated carbon is a function of the particular vapor in question, the adsorbent, the adsorbent temperature, and the vapor concentration. Removal of gaseous vapors by physical adsorption is practical for gases with molecular weight over 45.[71] Each type of activated carbon has its own adsorbent properties for a given vapor and the quantity of vapor adsorbed for a particular vapor concentration in the gas and at a particular temperature is best determined experimentally. The quantity of vapor adsorbed increases when the vapor concentration increases and the adsorbent temperature decreases.

After breakthrough has occurred, the adsorbent is regenerated by heating the solids until the adsorbate has been removed. A carrier gas must also be used to remove the vapors released. Low pressure saturated steam is used as the heat source for activated carbon and acts as the heat source and carrier gas. Superheated steam (350°C) may be necessary to remove high boiling compounds and return the carbon to its original condition. It is not necessary to use superheated steam until high boiling compounds have reduced the carbon capacity to the point where complete regeneration is necessary.

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[71] Perry, J. H., and Chilton, C. H., Chemical Engineers' Handbook, McGraw-Hill, New York, N.Y., 1973.

Steam requirements for regeneration are a function of external heat losses and the nature of the solvent. The amount of steam adsorbed per pound of solvent as a function of elapsed time passes through a minimum. The carbon should be regenerated for this length of time to permit the minimum use of steam.[71] After regeneration the carbon is hot and saturated with water. Cooling and drying are done by blowing solvent-free air through the carbon bed. Evaporation of the water aids cooling of the carbon. If high temperature steam has been used, other means of cooling the carbon are required. Adsorbers for removal of solvent vapors from air are fixed bed adsorbers arranged in two or more parallel bed arrangements. These are batch-type arrangements, where a bed is used until breakthrough occurs and is then regenerated. The simplest adsorber system of this type is a two-bed system where a carbon bed is being regenerated as the other bed is used to adsorb organic vapors. A three-bed arrangement permits a greater quantity of solvent to be adsorbed per unit of carbon by passing the effluent through two beds in series while the third bed is regenerated. This permits the activated carbon to be used after breakthrough since the second bed in the series removes solvent vapors in the first bed exit gas. When the first bed is saturated, it is removed from the stream for regeneration, the bed which was used to remove the final traces of solvent vapors from the effluent becomes the new first bed, and the bed which has been regenerated becomes the new second bed.

Heat is released in the adsorption process, which causes the temperature of the adsorbent to increase. If the concentration of solvent vapors is not high, as in the case of paint spraying or coating operations, the temperature rise is typically 10°C.[4]

The pressure drop through a carbon bed is a function of the gas velocity, bed depth, and the carbon particle size. Activated carbon manufacturers supply empirical correlations for pressure drop in terms of these quantities. These correlations usually include pressure drop resulting from directional change of the gas stream at inlet and outlet.

Control of solvent vapor emissions by adsorption on activated carbon is applied when recovery of the adsorbate is economically desirable. Other applications include control of halogenated organics which cannot be controlled by incineration because of acid formation and for concentrating low-concentration emissions for subsequent disposal by incineration.[4]

2. Absorption

Absorption is the removal of one or more soluble components in a gas mixture by dissolving these components in a liquid. The absorption process may consist of dissolving the component in a liquid followed by reaction with a reagent, or, as in the case of the removal of solvent vapors from air by absorption in a lean oil, by solution without reaction.

The equipment used for continuous absorption can be a tower filled with a solid packing material, an enclosure through which the gas flows and into which the liquid is sprayed, or a tower which contains a number of bubble-cap, sieve, or valve-type plates. Absorption operations are carried out in wetted wall columns (a tubular column in which the gas flows vertically through the tube and the liquid flows down over the column wall), stirred vessels, or other types of equipment.

Packed towers or plate towers are used for absorption. Each has advantages which are listed below.

Packed towers

- Can be designed for a lower pressure drop than a plate tower and still maintain vapor-liquid contact.
- Handle foaming liquids more satisfactorily.
- Liquid holdup is less.
- Construction is cheaper and simpler when corrosive materials must be handled.
- Small packed towers (less than two feet in diameter) do not cost as much as plate towers.

Plate towers

- Cooling coils are more readily installed on plates when heat of solution requires internal cooling.
- With proper design, plate towers can handle a wider range of liquid rates.

- Certain types of plate towers may be preferred when there are deposits of solid material that must periodically be removed. The cleaning of plate towers can be accomplished through manholes, but packed towers require dumping of the packing for cleaning.

- The weight of a plate tower is less than the weight of a packed tower designed for the same duty. Also, packing support plates may be required to prevent crushing of the packing and to bear the weight of the packing in a tall tower.

- Plate columns are preferred for operations that require a large number of transfer units because proper vapor and liquid stream distribution is difficult to maintain in packed towers.

The design of absorbers has been discussed by Treybal[72] and Perry and Chilton.[71] The problems which arise in designing absorbers can be attributed to variation of solubilities because of non-isothermal operating conditions, non-ideal liquid solutions, and the change in the gas and liquid flow rates caused by transfer of the solute from the gas phase to the liquid phase.

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[72] Treybal, R. E., Mass Transfer Operations, McGraw-Hill, New York, New York, 1968.

3. Incineration

a. Thermal Incineration - Direct flame afterburners depend upon flame contact and high temperatures to burn combustible materials in gaseous effluents to carbon dioxide and water.[73] The combustible materials may be gases, vapors, or entrained particulate matter which contribute opacity, odor, irritants, photochemical reactivity, and toxicity to the effluent. Direct-flame afterburners consist of a refractory-lined chamber, one or more burners, temperature indicator-controllers, safety equipment, and sometimes heat recovery equipment.[73]

The afterburner chamber consists of a mixing section and a combustion section. The mixing section provides contact between the contaminated gases and the burner flame. Good mixing is provided by high velocity flow which creates turbulence. The combustion section is designed to provide a retention time of 0.3 to 0.5 second for completion of the combustion process. Afterburner discharge temperatures range from 540°C to 800°C (1000°F to 1500°F), depending on the air pollution problem. Higher temperatures result in higher afterburner efficiencies.[73]

The gas burners used in afterburners are nozzle-mixing, premixing, multiport, and mixing plate burners. The method of burner placement depends on the burner type and on the design objective of providing intimate contact of the contaminated air with the burner flames. When all the contaminated air passes through the burner, maximum afterburner efficiency is obtained.[73]

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[73] Rolke, R. W., et al., Afterburner Systems Study, PB-212 560, 1972.

Nozzle mixing and premixing burners are arranged to fire tangentially into a cylindrical afterburner. Several burners or nozzles are required to ensure complete flame coverage, and additional burners or nozzles may be arranged to fire along the length of the burner. Air for combustion of fuel is taken from outside air or from the contaminated air stream. The contaminated air stream is introduced tangentially or along the major axis of the cylinder.[73]

Multiport burners are installed across a section of the afterburner separate from the main afterburner chamber. Although all air for combustion is taken from the contaminated air stream, multiport burners are not capable of handling all of the contaminated air stream through the burner. Provision must be made for passing contaminated air, in excess of that used for fuel combustion, around the burner and mixing this air with the burner flames in a restricted and baffled area.[73]

Mixing plate burners were developed for afterburner applications. Mixing plate burners are placed across the inlet section of the afterburner. Mixing of the contaminated air and the burner flames is provided by profile plates installed around the burner between the burner and afterburner walls. The burner and profile plate design provides high velocities (100 cm/sec) which ensures mixing of the burner flames and the contaminated air not flowing through the burner. The contaminated air stream provides air for fuel combustion.[73]

The efficiency of an afterburner is a function of retention time, operating temperature, flame contact, and gas velocity. No quantitative mathematical relationship relating efficiency to these variables exists because the kinetics of the combustion process are complex and flow inside afterburners is not defined. However, for good afterburner design, the following observations with respect to afterburner efficiency can be made.[73]

- Efficiency increases with increasing afterburner operating temperature.

- Efficiency decreases if excessive preheat is given to the contaminated gases entering the afterburner.

- Efficiency increases with increasing contact between the contaminated gases and the burner flame.

- Efficiency increases with increasing retention time for retention times less than one second.

- Efficiency is a function of the afterburner design and the inlet concentration of organic materials.

- Ninety percent afterburner efficiency is difficult to reach below 700°C (1300°F) operating temperature if the generation of carbon monoxide in the afterburner is included.

b. Catalytic Incineration - A catalytic afterburner contains a preheat burner section, a chamber containing a catalyst, temperature indicator and controllers, safety equipment, and heat recovery equipment. The catalyst in a catalytic afterburner promotes combustion by increasing the rate of the oxidation reactions without itself appearing to change chemically.

The contaminated air entering a catalytic afterburner is heated to the temperature necessary for carrying out the catalytic combustion. The preheat zone temperature, which falls in the range 340°C to 600°C (650°F to 1100°F), varies with the combustion and type of contaminants. Because of thermal incineration in the preheat zone, the preheat burner can contribute to the efficiency of a catalytic afterburner.

Catalysts used for catalytic afterburners may be platinum family metals supported on metal or matrix elements made of ceramic honeycombs. Catalyst supports should have: (1) high geometric surface area; (2) low pressure drop; (3) structural integrity and durability; and (4) a system in which uniform distribution of the flow of waste stream through the catalyst can be obtained. Catalysts can be poisoned by phosphorus, bismuth, arsenic, antimony, mercury, lead, zinc, and tin, which are thought to form alloys with the metal catalyst. Catalysts are deactivated by materials which form coatings on the catalyst such as particulate material, resins, and carbon formed during organic material breakdown. High catalyst temperatures will also deactivate catalysts. Because the combustion reaction is exothermic, the catalyst bed temperature is above the inlet temperature, the temperature increase depending on the concentration of organic material burned and the heat of combustion of that material. Compensation for decreased catalyst activity can be made by: (1) initial overdesign in specifying the quantity of catalyst required to attain required performance; (2) increasing preheat temperature as chemical activity decreases; (3) regenerating the catalyst; and (4) replacing the catalyst.

The quantity of catalyst required for 85 to 95% conversion of hydrocarbons ranges from 0.5 to 2 m^3 catalyst/1000 m^3/min waste stream. Although the catalyst temperature required depends on the hydrocarbon burned and the condition of the catalyst, the operating temperature of catalytic afterburners ranges from 260°C to 540°C (500°F to 1000°F).[73]

B. SOLVENT REFORMULATION

There has been an emphasis on reformulation of solvent-based coatings to exempt solvents to meet the requirements of Rule 66-type legislation. The reformulated solvent systems are more complex than the former systems and also are more expensive.[74] In reformulating products, manufacturers must attempt to retain desired properties.[75] The replacement of methyl isobutyl ketone (MIBK), selling for 17 to 18-1/2¢/lb[72] in 1974, is an example. To replace MIBK, a medium drying solvent, a manufacturer might use methyl ethyl ketone (MEK), costing 18¢/lb.[76] But MEK is a fast-drying solvent and, thus, would have to be blended with slower drying isobutyl acetate (50-52¢/lb)[76] or n-butyl acetate (20-25¢/lb),[76] both of which are exempt from Rule 66-type regulations, along with xylene. Low cost aromatics are also used as much as possible. For example, as much as 16% of a formulation is toluene, with the rest rule-exempt solvents (Rule 66 permits 20% toluene, but allowance must be made for aromatics in naphthas used in the formulating). This type of reformulation increases the product cost by 3-5¢/gal above that of the original formulation based on toluene.[75]

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[74] Sweet, J. H., Solvents and Their Place in Air Pollution Regulations, Journal of Paint Technology, Vol. 45, No. 581, June, 1973.

[75] Anon., New Rules Dull Solvent's Sheen, Chemical Week, November 15, 1972.

[76] Chemical Marketing Reporter, September 30, 1974.

Another type of reformulation which reduces emissions of organic solvents instead of just "reactive" (as defined by Rule-66) solvents is the reformulation to water-based coatings. Water differs from organic solvents in physical properties (see Table 26).[77] Examples are its large heat of vaporization, difference between freezing and boiling points, and boiling point elevation constant.[77] Thus, water is a costly solvent to evaporate and its rate of evaporation is difficult to control with additives.[66,77] The films resulting from water-based paints are often less glossy than those from solvent-based paints.[66] Other disadvantages are the tendency of water-based coatings to rust metal and their inability to adhere to surfaces contaminated with even a small amount of oil or other hydrophobic dirt.[66] Finally, such coatings are typically more costly than equivalent solvent-based coatings.[66]

C. VAPOR CONDENSATION

Because of the explosion and fire hazards, insurance regulations require that surface coating operations be well ventilated. Solvent concentrations in the effluent from surface coating operations range from 100 to 200 ppm.[67] Calculations show that for condensation of organic vapors by cooling, refrigeration requirements would be very costly. For example, to obtain 90% recovery of toluene vapors being

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[77] McEwan, I.H., Role of Water in Water-Reducible Paint Formulations, Journal of Paint Technology, Vol. 45, No. 583, August, 1973.

Table 26. PHYSICAL PROPERTIES OF WATER AND ORGANIC SOLVENTS[74]

Property	Water	Mineral spirits	Acetone	Xylene
B.P., °C	100	214.5	56.5	144
F.P., °C	0	-12	-95	-25
(B.P.-F.P.), °C	100	226.5	151.5	169
Solubility parameter	23.5	6.6	10	8.8
Latent heat of vaporization, cal/g at B.P.	540	115	135	94
B.P. elevation constant	0.51	2.79	1.33	2.67
Surface tension, dynes/cm	73	18	24	30

emitted at a rate of 113 kg/day with a concentration of 0.45 kg per 1000 m^3 of air would require over 450 tonnes of refrigeration.[6]

SECTION VII

GROWTH AND NATURE OF THE INDUSTRY

A. PRESENT TECHNOLOGY

One surface coating process which has demonstrated rapid growth in recent years is coil coating. The number of square feet of metal run through coil coating lines has been increasing at 15 to 20% per year, compared to 4 to 5% per year for industrial coatings in general.[66] The use of coil coating in metal for cans and closures has grown even more rapidly, at a 40% per year rate.[67] The National Coil Coaters Association, for instance, estimates that 95% of the aluminum used in cans and closures has been coil coated.[66] Figure 32 shows the growth of coil coating since 1962.

Coil coating offers several advantages. First, although installation costs are high (running up to $1 million), there is probably no cheaper way to apply paint.[66] Labor costs are low and little paint is wasted.[66] The method also produces very uniform films; however, the thickness of the films is limited.[66] Older coil coating lines operate at 46 to 61 meters per minute, but lines running at 92 meters or more per minute are common.[66] Some of the newest lines, in fact, are capable of speeds of at least 185 meters per minute, but limitations in the rate of applying and curing coatings cut the practical speed to half of that figure.[66]

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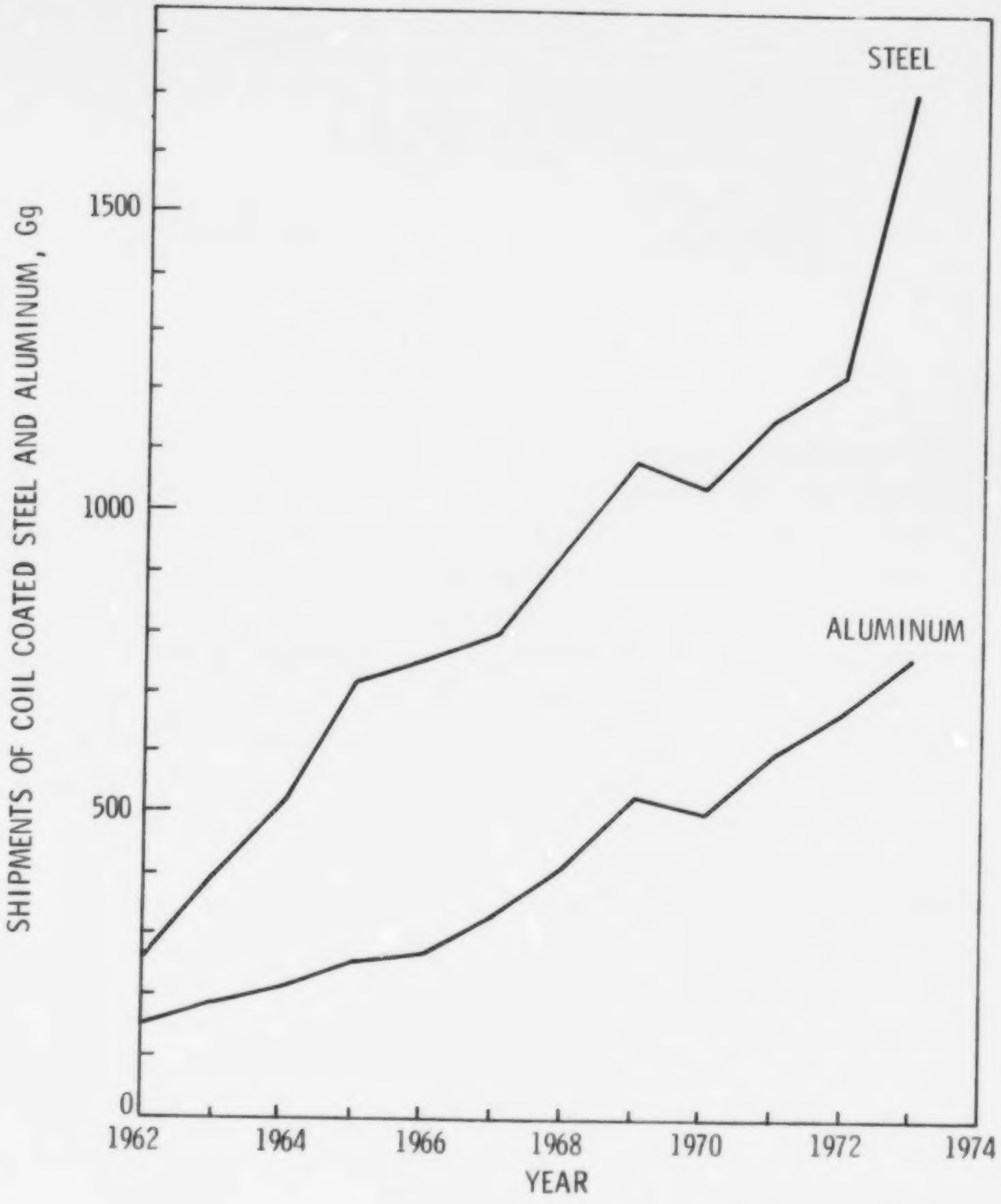

Figure 32. Coil coated metal production (includes Canada and Mexico)

Also growing fast among application techniques is electrodeposition or electrocoating.[66] This technique was pioneered in this country by the Ford Motor Company in association with the coatings companies during the 1950's.[66,67] The first large scale use was the electrocoating of automobile bodies at Ford's Wixon, Michigan plant in 1963.[66] The electrocoating process has all the advantages of a simple dip coating operation, but overcomes many of the problems associated with that method.[66] Its major advantage is the ability to form a firm, even coat on surfaces that are difficult to reach by other methods.[66] The coating builds up on sharp edges just as evenly as it does on flat surfaces.[74] It is also deposited on recessed areas and will even penetrate between riveted or bolted sections or into small imperfections. Film thicknesses are easily controlled and labor costs are low because the entire operation can be automated.[66] Since water is used as the solvent,[66,67] the fire hazard is minimized. The operation is also fast; an auto body can be coated within two or three minutes.[74]

Electrocoating does have drawbacks, however. Although operating costs are low, the installation of an electrodeposition tank is expensive.[66,67] A small tank of 5000 gallons capacity might cost $25,000 to $250,000 with auxiliary equipment.[66] A large tank holding 50,000 to 65,000 gallons of paint can cost $1.5 to $2 million.[66] Another drawback is that only a single coat can be applied, since the initial coat acts as an electrical insulator and prevents additional deposition.[66] Furthermore, as with any dipping operation, changing color during a production run is time consuming and difficult.[66] The present market for paints used in electrocoating tanks is $7 to $10 million, with about $3.5 to $4 million going to the auto industry.[66]

B. EMERGING TECHNOLOGY

An application technique which has been around some time is powder coating.[66] Application of plastic powders to preheated metal components was carried out as long as thirty years ago.[78] The procedure, however, only became economical and reliable following the introduction in 1953 of fluidized beds by Edwin Gemmer.[78]

Powder coating offers many advantages over solvent-type painting:[78]

- No solvent is employed
    - No costly waste of solvents
    - No inflammable solvents
    - No pollution from solvents
    - Reduced health hazard to operators
    - No flash-off period required
    - No energy wasted in driving off solvents
- Nearly 100% effective use of powder coating can be attained.
- Fairly uniform and higher film thickness than solvent-bearing enamel is obtained in one application.
- No sagging, bridging, or poor coverage occurs at edges.

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[78] Kut, S., Product Finishing with Electrostatically Sprayed Powder Coatings, Science and Technology of Surface Coating, Academic Press, London, England, and New York, New York, 1974.

Powder coating does have disadvantages. The application of the technique is limited to substrates that can withstand high temperatures.[67] Also, although the fire hazard associated with solvents is eliminated, organic powders are flammable; moreover, at critical powder-air concentrations ($\sim$53 g/m^3) a dust explosion can occur with an ignition temperature of 460°C.[78]

Other limitations have also presented difficulties to the wide use of powder coating. The transfer efficiency of powder coating is poor, since much must be applied as a spray (e.g., auto body painting). Efficiencies on automotive lines have been as low as 60%.[79] Efficiencies in powder usage must approach 90 to 95% to be economical.[79] Another limitation of powder coating is the difficulty in changing colors and contamination encountered in changing colors. Unlike solvent-based paints which allow contamination to blend to form a slightly different shade at worst, color contamination of powder shows as spots on the final product.[76] Powder coating presently represents a market for $7 to $9 million worth of coating materials a year.[66] It is projected that this will double by 1980 to include 7% of the market share.[79]

A new curing technique, high energy curing, has stirred interest for about ten years,[67] but has yet to make its mark commercially.[66] Ford Motor Company's patented Electrocure process, an electron beam curing process, has been used on a pilot scale by Boise Cascade at its Boise, Idaho plant for lumber products.[66] The same process has been installed for electron beam curing of coated coil by Wolverine Petronix in Lincoln Park, Michigan.[67]

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[79] Edwards, P., Coatings '74/Solvents, Chemical Marketing Reporter, November 4, 1974.

The biggest advantages of high energy curing are its speed and the elimination of heat from the curing process.[66,67] A coating can be cured within a few seconds and curing is carried out without damage to heat-sensitive substrates (e.g., wood or plastic).[66] Because of its speed, the first widely used application of high energy curing may be in coil coating.[66] The speed of the fastest lines might be doubled or tripled if the space-consuming ovens were replaced.[66]

The technique does have some serious limitations. First, it cannot be applied to most present-day resin formulations. These resins depend upon heat applied in the curing cycle to polymerize or cross-link the resins.[66] Furthermore, since the electron beam has only limited penetration, the maximum thickness of the coating is limited to about 0.25 mm.[66] Finally, high energy curing equipment is expensive. Total cost of a facility with one accelerator, auxiliary equipment, and shielding runs to $200,000 or more.[66] Therefore, to be used economically, the process requires a large production volume.[67] In spite of these disadvantages, proponents of the technique are convinced that electron beam curing will win a firm niche commercially.[66]

C. INDUSTRY PRODUCTION TRENDS

For a long time, trade sales were the major outlet for the surface coating industry. After 1970, however, the situation reversed and industrial sales assumed the major role. Figure 33 shows the industry trend in terms of cubic meters of paint production. Figure 34 shows the same trend in terms of dollars of sales.

Figures 35 through 41 show sales or production trends for selected products from the major categories.

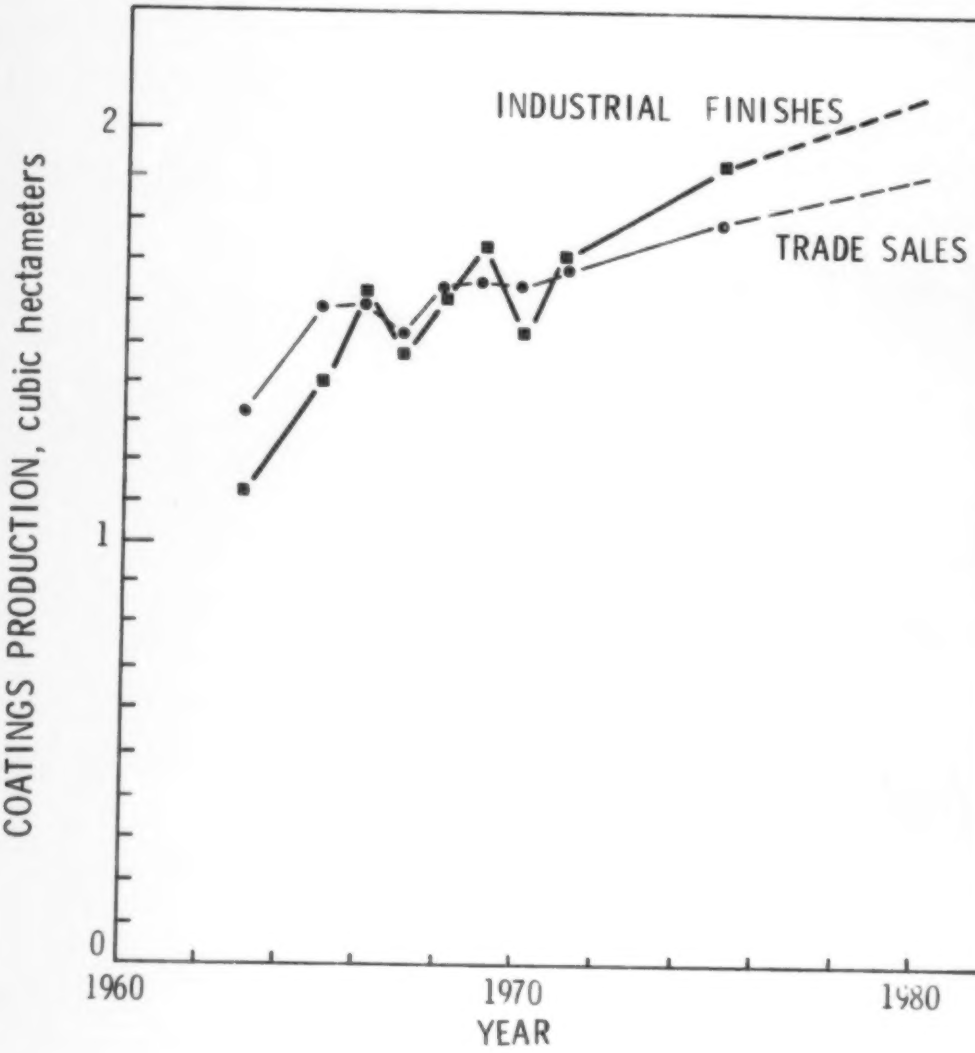

Figure 33. Paints and allied products production

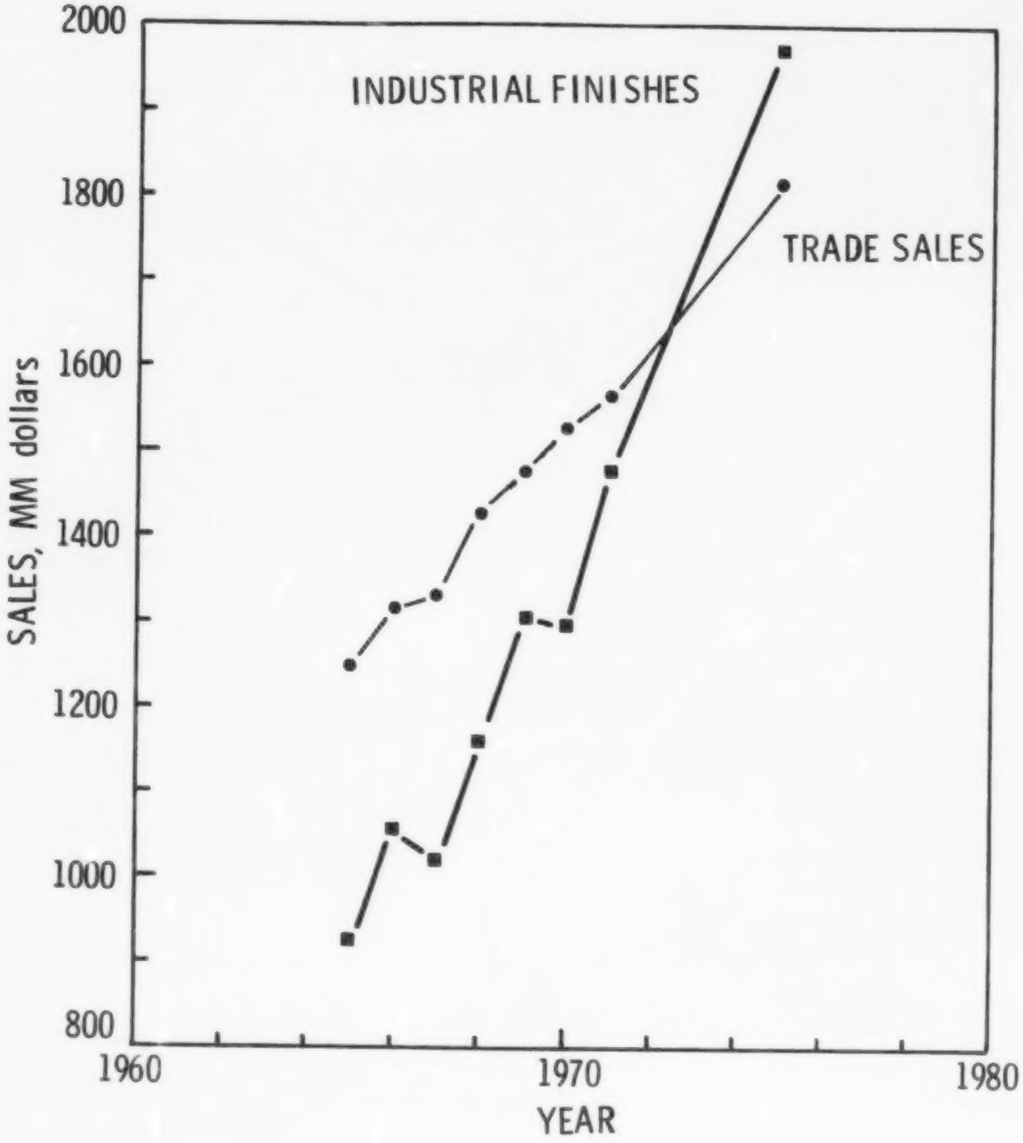

Figure 34. Paints and allied products sales

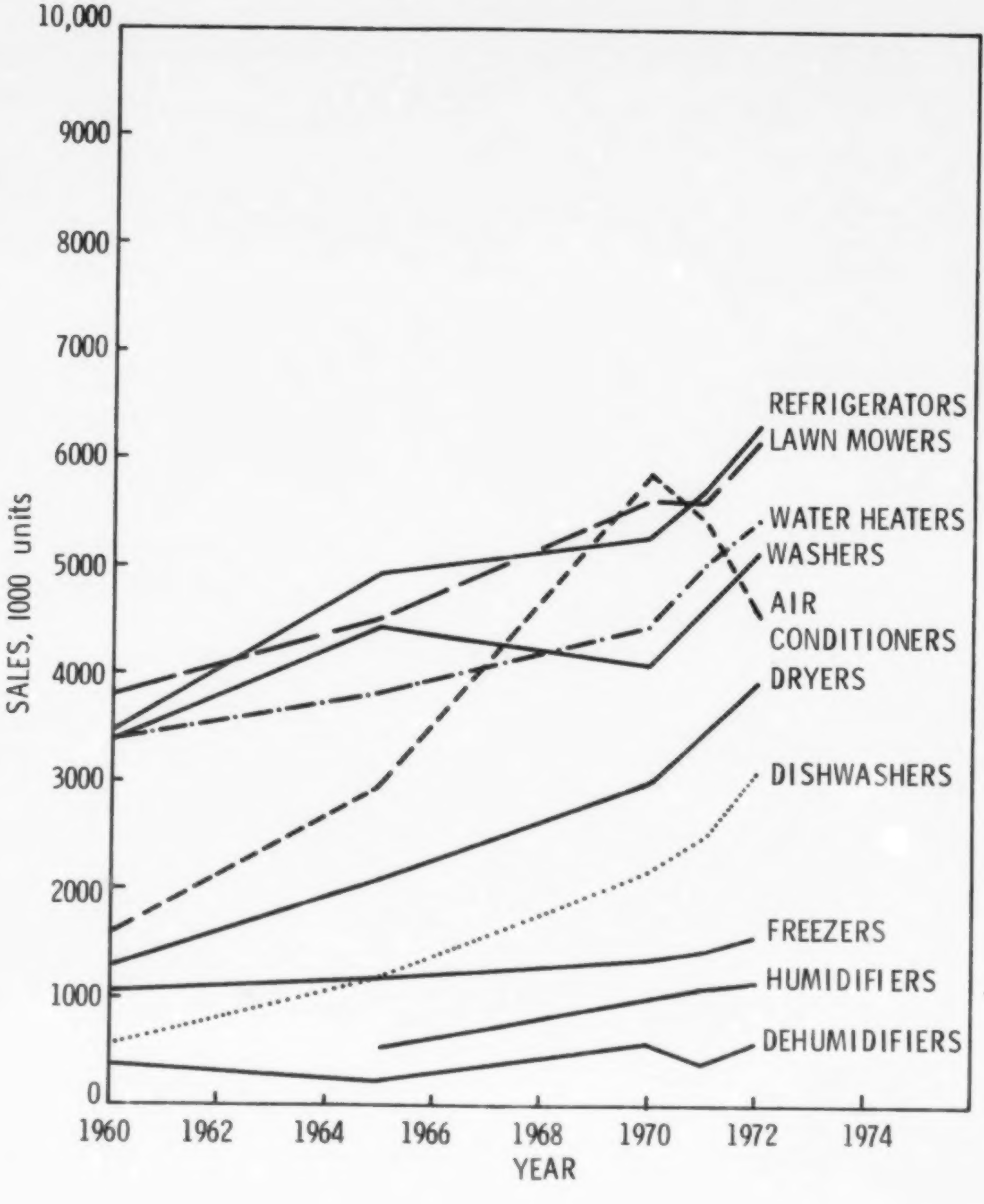

Figure 35. Sales trends of major appliances

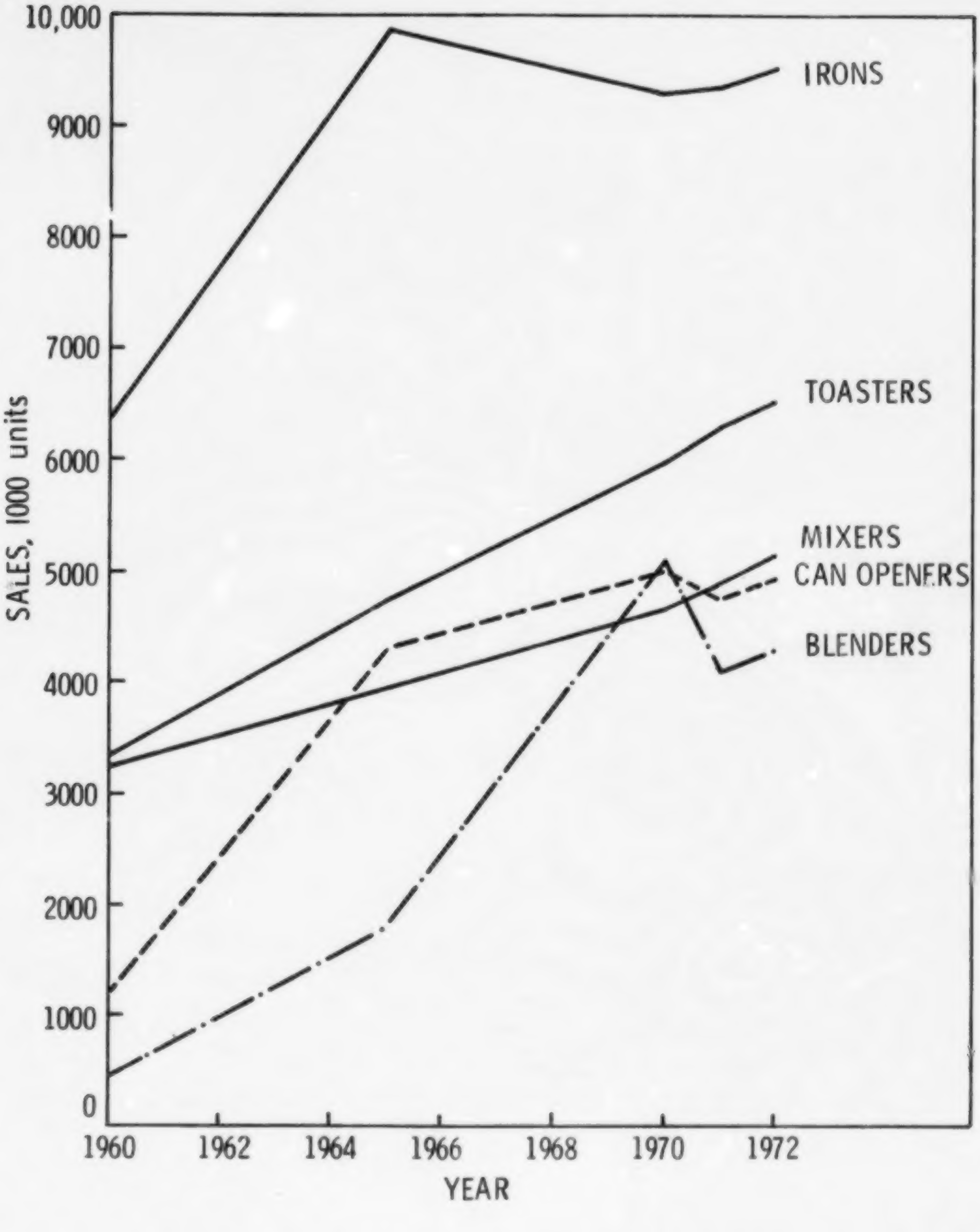

Figure 36. Sales trends of small appliances

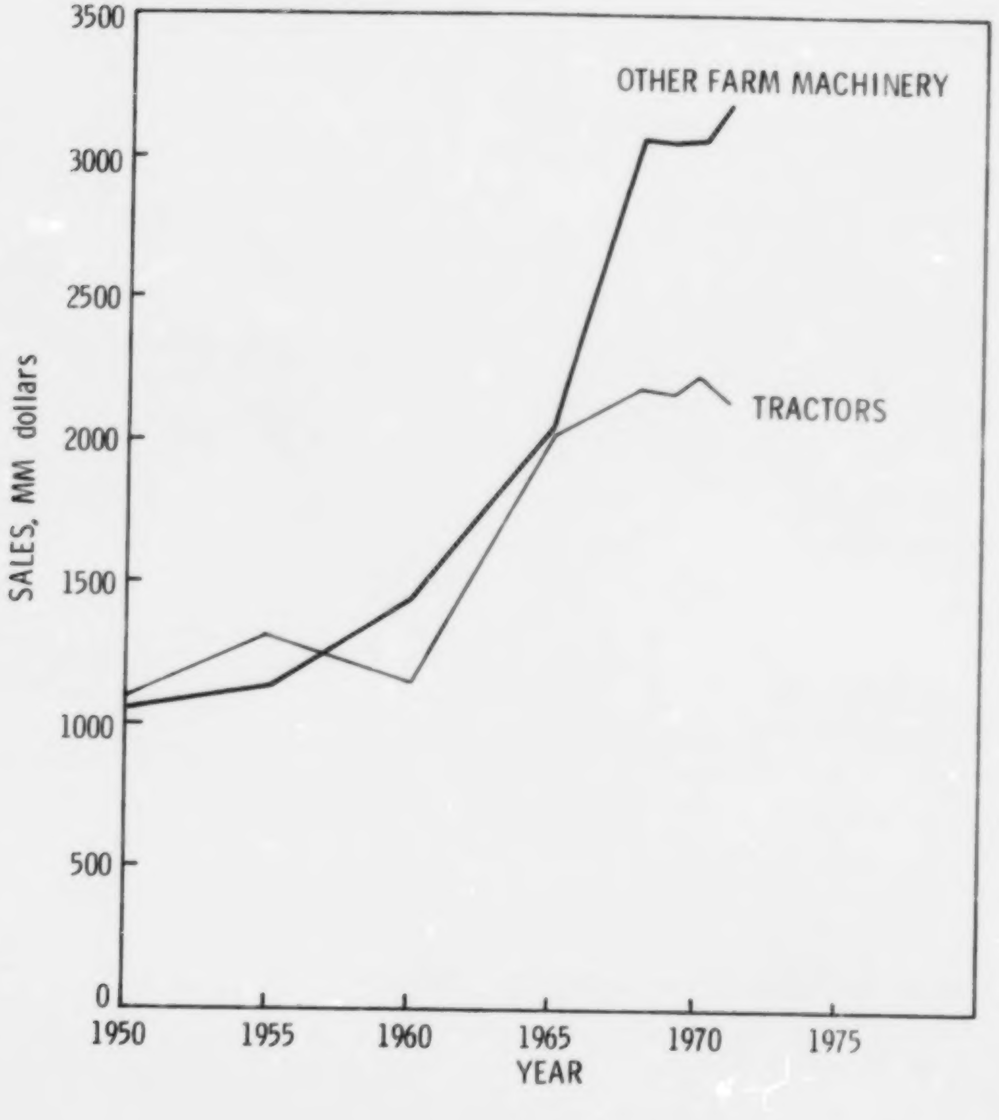

Figure 37. Sales trends for farm machinery

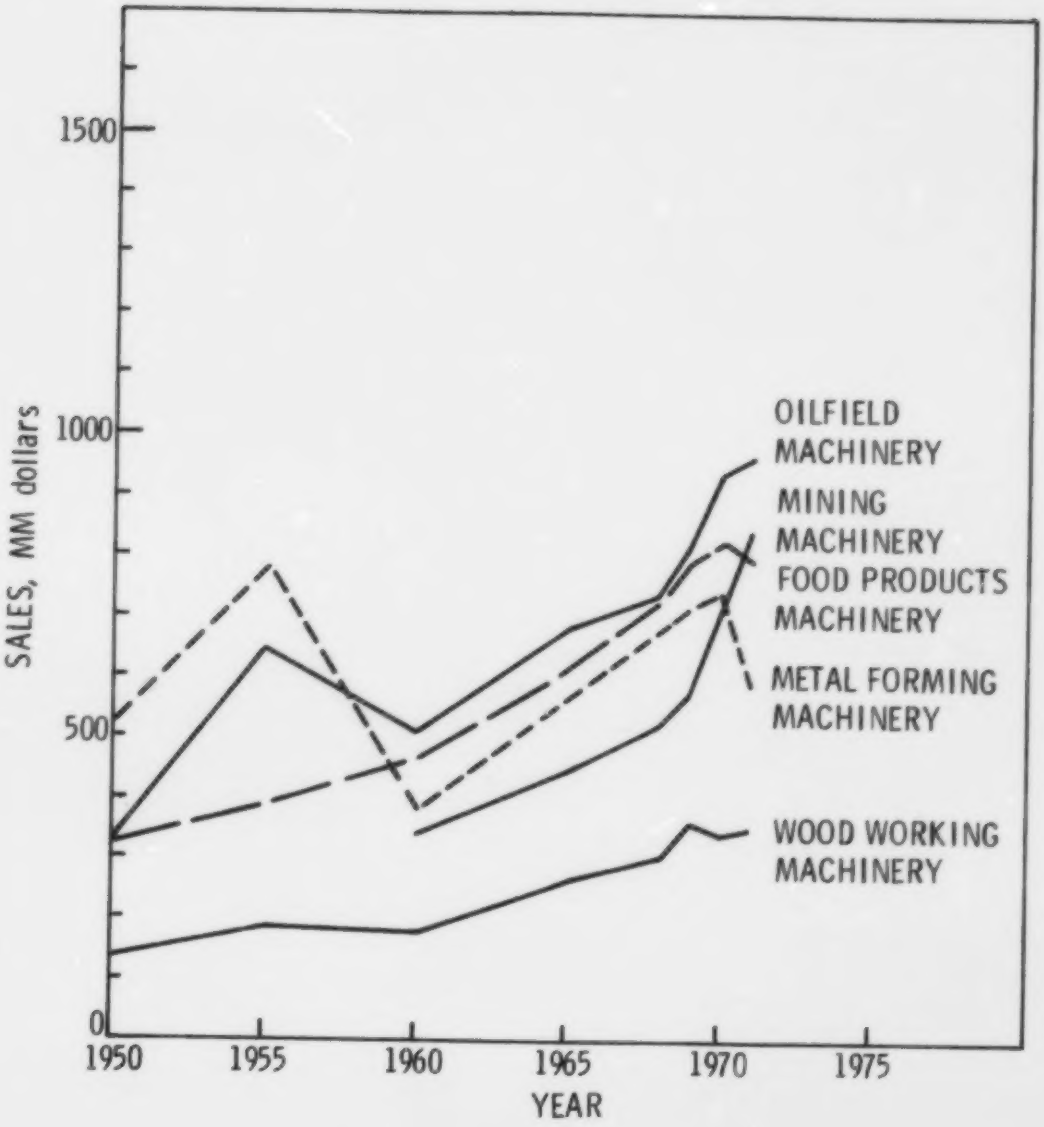

Figure 38. Sales trends of industrial machinery

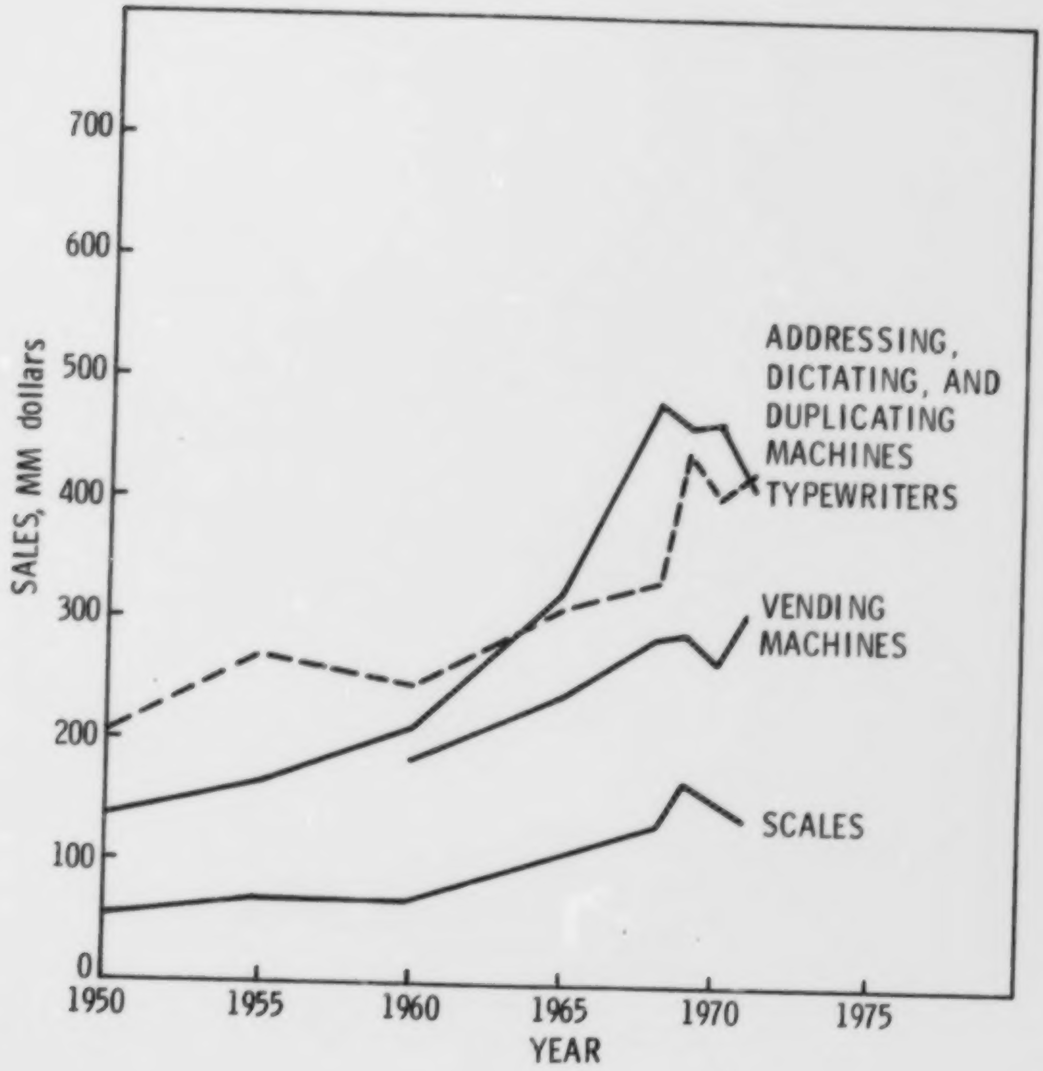

Figure 39. Sales trends for commercial machinery

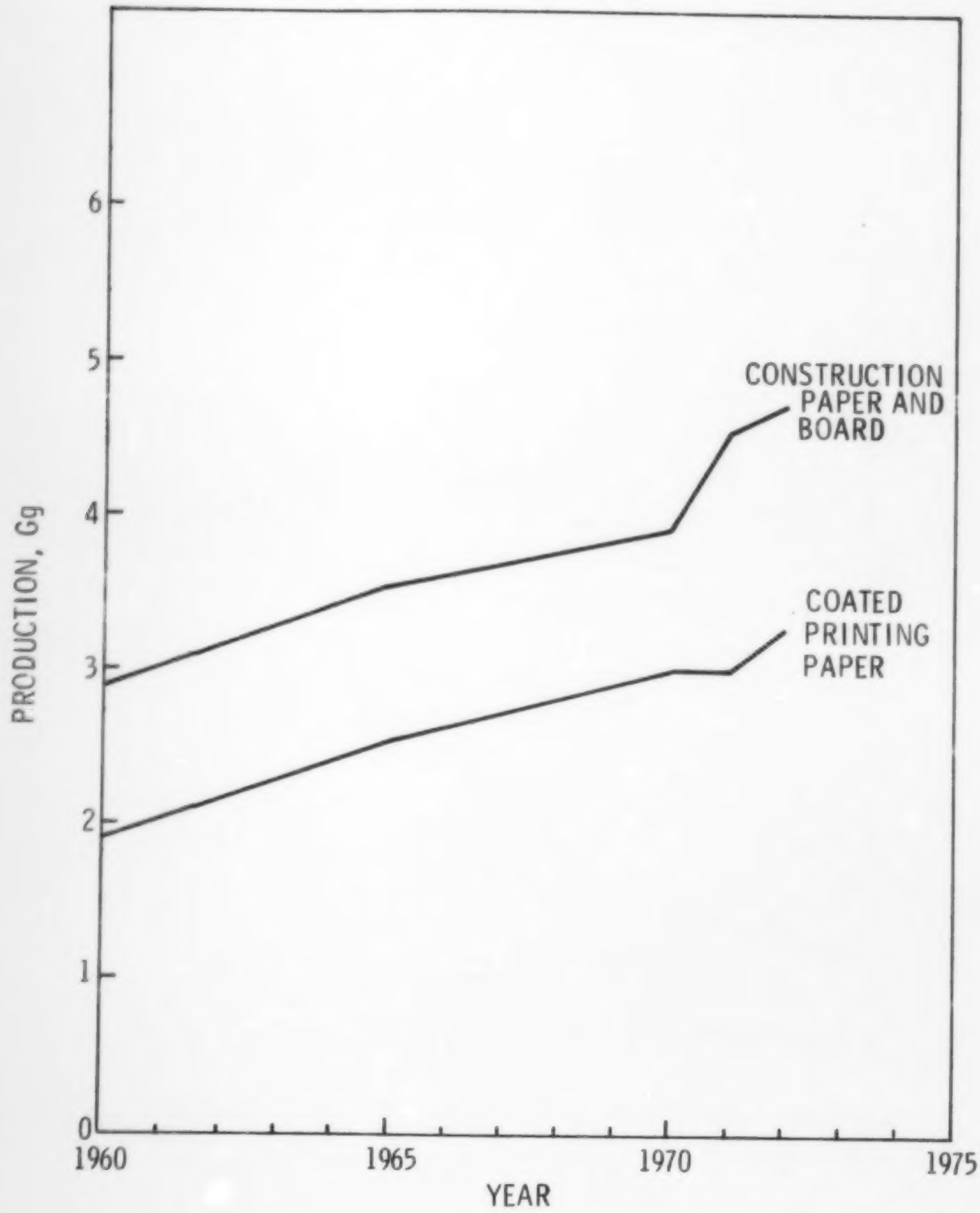

Figure 40. Production trends in the paper and paperboard industry

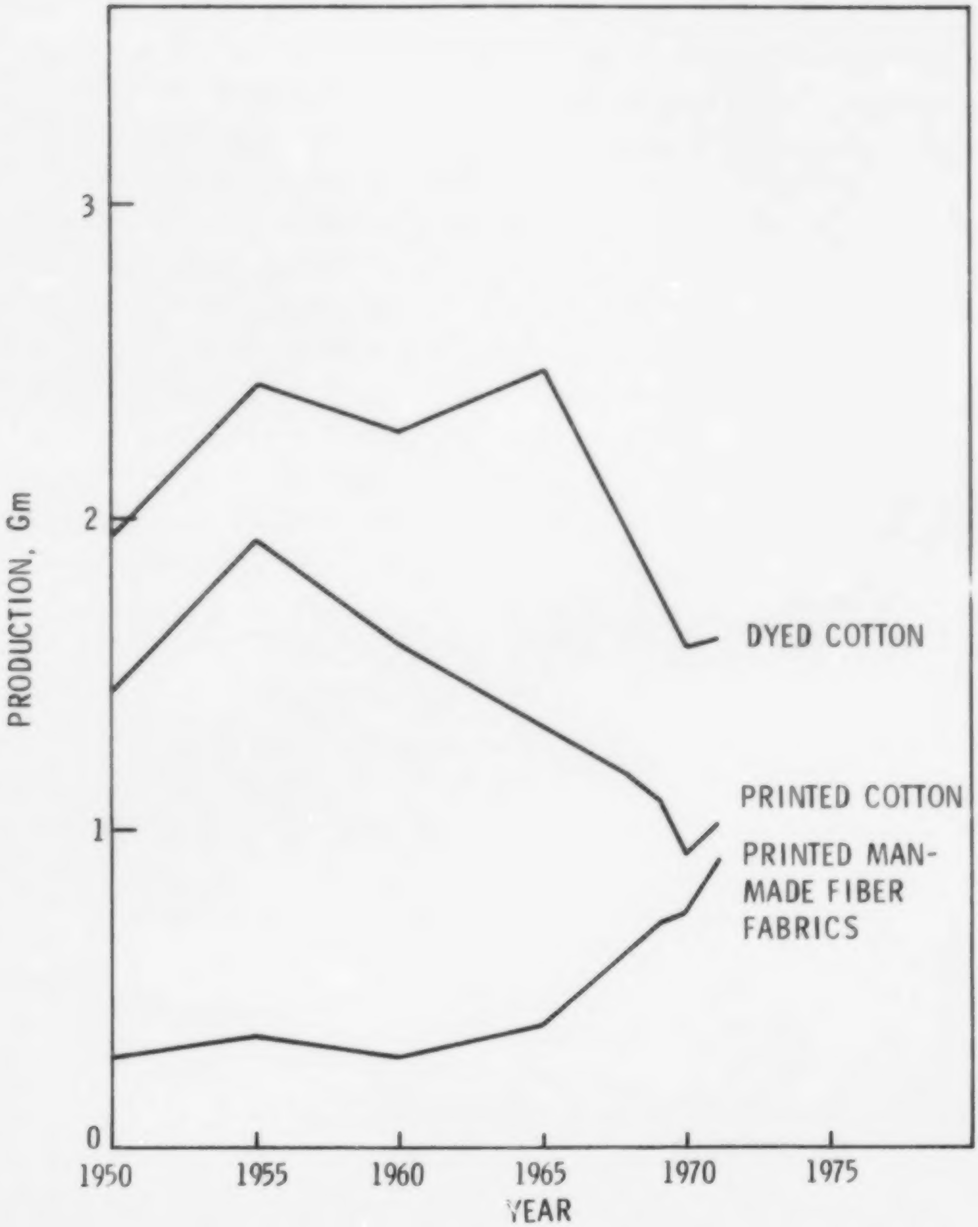

Figure 41. Production trend of textiles

D. EFFECT UPON IMPACT FACTOR

As industry production rates change and as technology changes, the impact factor for each product also changes, and consequently, the priority ranking may also change. To demonstrate these changes, the ten major appliances given in Table 27 are used as an example. Table 27 lists the ten in order of decreasing impact factor (based on actual TLV values). However, if it is assumed that the growth rate of each product from 1971 to 1972 extended linearly to 1976 with no changes in technology, the 1976 priority ranking would be as shown in Table 28. Furthermore, if it is assumed that 50% of refrigerator and freezer production is powder coated in 1976 in addition to the changed production, the priority ranking would be as shown in Table 29.

Table 27. 1972 PRIORITY RANKING FOR SURFACE COATING OF TEN SELECTED MAJOR APPLIANCES

Rank number	Product type	Impact factor
1	Refrigerators	6,000
2	Dryers	3,000
3	Washers	2,000
4	Freezers	2,000
5	Water heaters	2,000
6	Air conditioners	1,000
7	Dishwashers	800
8	Lawn mowers	300
9	Humidifiers	200
10	Dehumidifiers	100

Table 28. 1976 PRIORITY RANKING FOR SURFACE COATING OF TEN SELECTED MAJOR APPLIANCES WITH PRESENT TECHNOLOGY

Rank number	1972 Rank number	Product type	Impact factor
1	1	Refrigerators	8,000
2	2	Dryers	5,000
3	3	Washers	3,000
4	4	Freezers	3,000
5	5	Water heaters	3,000
6	7	Dishwashers	1,000
7	8	Lawn mowers	400
8	9	Humidifiers	300
9	10	Dehumidifiers	200
10	6	Air conditioners	200

Table 29. 1976 PRIORITY RANKING FOR SURFACE COATING OF TEN SELECTED MAJOR APPLIANCES WITH CHANGED TECHNOLOGY

Rank number	1972 Rank number	Product type	Impact factor
1	2	Dryers	5,000
2	1	Refrigerators	4,000
3	3	Washers	3,000
4	5	Water heaters	3,000
5	7	Dishwashers	1,000
6	4	Freezers	1,000
7	8	Lawn mowers	400
8	9	Humidifiers	300
9	10	Dehumidifiers	200
10	6	Air conditioners	200

SECTION VIII

APPENDICES

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SURFACE COATING EMISSION FACTORS - SAMPLE CALCULATION

The emission factors presented in Tables A-1 to A-24 were calculated from the data presented in Table 18. These data also appear in the Air Pollution Engineering Manual, AP-40, Second Edition, page 864, Table 223. The emission factors presented in Tables A-25 to A-43 are Monsanto Research Corporation estimates.

A sample calculation demonstrating how the emission factors for Tables A-1 to A-24 were determined is presented below. The surface coating to be used for the sample calculation is Lacquer, Hot Spray (Table A-13).

The data presented in AP-40 for Lacquer, Hot Spraying are shown below.

Density = 1.01 kg/l (8.4 lb/gal)

Non-volatile portion = 16.5% by volume

Volatile portion = 83.5% by volume

The volatile portion consists of the following:

Aliphatic Hydrocarbons = 16.4% by volume of volatiles

Aromatic Hydrocarbons = 6.8% by volume of volatiles

Alcohols = 24.3% by volume of volatiles

Ketones = 17.2% by volume of volatiles

Esters = 14.8% by volume of volatiles

Ethers = 20.5% by volume of volatiles

100.0%

These data were all converted to the same basis, namely, volume percent of total surface coating. The aliphatic hydrocarbons (16.4% by volume of volatiles) was multiplied by 0.835 (volatile volume fraction) to yield 13.7% by volume of surface coating as demonstrated below.

Volatile component	Volatile percent (% by volume of volatiles)	Volatile fraction (% by volume of surface coating)	Component percentage (% by volume of surface coating)
Aliphatic hydrocarbons	16.4	x 0.835	= 13.7
Aromatic hydrocarbons	6.8	x 0.835	= 5.7
Alcohols	24.3	x 0.835	= 20.3
Ketones	17.2	x 0.835	= 14.4
Esters	14.8	x 0.835	= 12.4
Ethers	20.5	x 0.835	= 17.1
Subtotals	100.0	x 0.835	= 83.5
Non-volatile component			= 16.5
TOTAL			= 100.0

The weight percent for each of the volatile components was determined by multiplying the component percent by the component density and dividing by the surface coating density. The component densities which were assumed are presented below.

Volatile component	Assumed species	Density (g/cc)
Aliphatic hydrocarbons	Paraffins	0.87
Aromatic hydrocarbons	Xylenes	0.86
Alcohols	Isopropanol	0.78
Ketones	Acetone	0.76
Esters	sec-Butyl acetate	0.86
Ethers	*	0.95

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*50/50 mixture of ethylene glycol monomethyl ether and ethylene glycol monoethyl ether.

The weight percents for each of the volatile components are presented below.

Volatile component	Component percent (% by volume of surface coating)	Component density	
		Coating density, g/cc/g/cc	Weight percent
Aliphatic hydrocarbons	13.7	x (0.87/1.01)	= 11.8
Aromatic hydrocarbons	5.7	x (0.86/1.01)	= 4.9
Alcohols	20.3	x (0.78/1.01)	= 15.9
Ketones	14.4	x (0.76/1.01)	= 10.8
Esters	12.4	x (0.86/1.01)	= 10.6
Ethers	17.1	x (0.95/1.01)	= 16.2
TOTALS	83.5		70.2

For surface coating operations, solvent emissions involves 100% evaporation of the solvent content of the surface coating. To determine the emission factors (g/m^2) of area covered) for surface coating, all that is necessary is to multiply the total area covered by the corresponding volatile component weight fraction. For this program, it was assumed that all surface coatings had a coverage of 7.35 m^2/liter (300 ft^2/gal).

A coverage of 7.36 m^2/liter (300 ft^2/gal) for Lacquer, Hot Spraying with a density of 1.01 kg/liter 8.4 lb/gal) corresponds to the following:

$$\text{Coated area} = \frac{8.4\ \text{lb}}{\text{gal}} \times \frac{\text{gal}}{300\ \text{ft}^2} \times \frac{453.6\ \text{g}}{\text{lb}} \times \frac{\text{ft}^2}{0.0929\ \text{m}^2}$$

$$= 136.7\ \text{g/m}^2$$

The volatile component emission factors were calculated as the product of weight fraction and coated area:

Volatile component	Weight fraction	Coated area, g/m^2	Emission factor, g/m^2
Aliphatic hydrocarbons	0.118	136.7	16.1
Aromatic hydrocarbons	0.049	136.7	6.6
Alcohols	0.159	136.7	21.2
Ketones	0.108	136.7	15.6
Esters	0.106	136.7	14.4
Ethers	0.162	136.7	22.1
TOTALS	0.702		96.0

The data presented in AP-40 does not consider resin material as a volatile component. However, the National Paint and Coatings Association reports resin emissions (see Table 20, page 82). A comparison of resin surface coating consumption and emissions are presented below.

Resin	Consumption,[5] 10^6 kilograms	Emissions,[59] 10^6 kilograms	Percent
Acrylic	100	12.2	12.2
Alkyd	268	40.5	15.1
Epoxy	32	14.1	44.1
Hydrocarbon	12	0.9	7.5
Phenolic	14	1.8	12.9
Urethane	22	3.3	15.0
Vinyl	118	9.2	7.8
		Average =	16.4 ± 12.6

For each of the surface coatings, it was assumed that 10% or less of the resin contained in the surface coating evaporated. For each of the surface coatings, the resin content of each surface coating type was assumed.

Table A-1. TYPE OF SURFACE COATING: ENAMEL, AIR DRY

Composition; weight fraction

Solvent: 0.5703

Resin: 0.2623

Pigment: 0.1674

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	66.2
Aromatic hydrocarbons	Toluene	0.375	4.4
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	3.8
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		74.4

Table A-2. TYPE OF SURFACE COATING: ENAMEL, BAKING

Composition; weight fraction

Solvent: 0.4323
Resin: 0.2623
Pigment: 0.3054

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	56.0
Aromatic hydrocarbons	Toluene	0.375	7.5
Saturated alcohols	n-Propyl alcohol	0.500	0.4
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	4.6
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		68.5

Table A-3. TYPE OF SURFACE COATING: ENAMEL, DIPPING

Composition; Weight fraction

Solvent: 0.2912

Resin: 0.2623

Pigment: 0.4465

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	28.4
Aromatic hydrocarbons	Toluene	0.375	3.4
Saturated alcohols	n-Propyl alcohol	0.500	13.4
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	1.7
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	5.0
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		51.9

Table A-4. TYPE OF SURFACE COATING: ACRYLIC ENAMEL

Composition; Weight fraction

Solvent:	0.5242
Resin:	0.2623
Pigment:	0.2135

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	5.5
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	60.2
Saturated esters	n-Butyl acetate	0.710	10.2
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	1.5
Acrylic	Methyl methacrylate	0.410	1.4
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diisocyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		78.8

Table A-5. TYPE OF SURFACE COATING: ALKYD ENAMEL

Composition; weight fraction

Solvent: 0.4683

Resin: 0.2623

Pigment: 0.2694

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	56.6
Aromatic hydrocarbons	Toluene	0.375	2.1
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	4.0
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		62.7

Table A-6. TYPE OF SURFACE COATING: PRIMER, VINYL ZINC CHROMATE

Composition; weight Fraction

Solvent: 0.3872
Resin: 0.2623
Pigment: 0.3505

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	11.0
Aromatic hydrocarbons	Toluene	0.375	5.3
Saturated alcohols	n-Propyl alcohol	0.500	11.8
Ketones	Methyl ethyl ketone	0.590	9.0
Saturated esters	n-Butyl acetate	0.710	9.9
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	12.4
Resin emissions			
Alkyd	Phthalic anhydride	0.012	1.6
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		61.0

Table A-7. TYPE OF SURFACE COATING: PRIMER SURFACER

Composition; weight fraction

Solvent: 0.2150

Resin: 0.2623

Pigment: 0.5227

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	16.7
Aromatic hydrocarbons	Toluene	0.375	5.6
Saturated alcohols	n-Propyl alcohol	0.500	1.0
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	10.3
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	3.1
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	15.5
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		52.2

Table A-8. TYPE OF SURFACE COATING: PRIMER, ZINC CHROMATE

Composition; weight fraction

Solvent: 0.4343
Resin: 0.2623
Pigment: 0.3034

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	59.3
Aromatic hydrocarbons	Toluene	0.375	5.0
Saturated alcohols	n-Propyl alcohol	0.500	8.4
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	1.8
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		74.5

Table A-9. TYPE OF SURFACE COATING: PRIMER, VINYL ZINC CHROMATE

Composition; weight fraction

Solvent: 0.5473

Resin: 0.2623

Pigment: 0.1904

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	13.8
Aromatic hydrocarbons	Toluene	0.375	6.0
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	42.2
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	12.9
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	1.4
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		76.3

Table A-10. TYPE OF SURFACE COATING: EPOXY-POLYAMIDE

Composition; weight fraction

Solvent: 0.4029

Resin: 0.2623

Pigment: 0.3348

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	14.4
Saturated alcohols	n-Propyl alcohol	0.500	17.5
Ketones	Methyl ethyl ketone	0.590	22.9
Saturated esters	n-Butyl acetate	0.710	14.0
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	5.0
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		73.8

Table A-11. TYPE OF SURFACE COATING: VARNISH, BAKING

Composition; weight fraction

Solvent: 0.6323

Resin: 0.2623

Pigment: 0.1044

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	65.5
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	2.6
Resin emissions			
Alkyd	Phthalic anhydride	0.012	3.3
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		71.4

Table A-12. TYPE OF SURFACE COATING: LACQUER, SPRAYING

Composition; weight fraction

Solvent: 0.6343

Resin: 0.2623

Pigment: 0.1034

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	6.1
Aromatic hydrocarbons	Toluene	0.375	1.3
Saturated alcohols	n-Propyl alcohol	0.500	16.4
Ketones	Methyl ethyl ketone	0.590	17.9
Saturated esters	n-Butyl acetate	0.710	38.2
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	1.6
Resin emissions			
Alkyd	Phthalic anhydride	0.012	4.0
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		85.5

Table A-13. TYPE OF SURFACE COATING: LACQUER, HOT SPRAY

Composition; weight fraction

Solvent: 0.6983
Resin: 0.2623
Pigment: 0.0394

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	16.1
Aromatic hydrocarbons	Toluene	0.375	6.6
Saturated alcohols	n-Propyl alcohol	0.500	21.2
Ketones	Methyl ethyl ketone	0.590	15.6
Saturated esters	n-Butyl acetate	0.710	14.4
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	22.1
Resin emissions			
Alkyd	Phthalic anhydride	0.012	3.6
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		99.6

Table A-14. TYPE OF SURFACE COATING: LACQUER, ACRYLIC

Composition; weight fraction

Solvent:	0.5041
Resin:	0.2623
Pigment:	0.2336

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	7.4
Aromatic hydrocarbons	Toluene	0.375	12.9
Saturated alcohols	n-Propyl alcohol	0.500	2.3
Ketones	Methyl ethyl ketone	0.590	27.3
Saturated esters	n-Butyl acetate	0.710	18.5
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	1.4
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
		TOTAL	69.8

Table A-15. TYPE OF SURFACE COATING: VINYL, ROLLER COAT

Composition; weight fraction

Solvent: 0.8749

Resin:

Pigment: 0.1251

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	41.4
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	67.2
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	1.3
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		109.9

Table A-16. TYPE OF SURFACE COATING: VINYL

Composition; weight fraction

Solvent: 0.5811

Resin: 0.2623

Pigment: 0.1566

Assumed coverage: 7.35 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	16.7
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	66.7
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	1.5
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		84.9

Table A-17. TYPE OF SURFACE COATING: VINYL ACRYLIC

Composition; weight fraction

Solvent: 0.7588

Resin: 0.2412

Pigment:

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	77.9
Saturated esters	n-Butyl acetate	0.710	13.9
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	1.2
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		93.0

Table A-18. TYPE OF SURFACE COATING: POLYURETHANE

Composition; weight fraction

Solvent: 0.5071

Resin: 0.2623

Pigment: 0.2306

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	14.8
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	9.7
Saturated esters	n-Butyl acetate	0.710	50.8
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	4.6
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		79.9

Table A-19. TYPE OF SURFACE COATING: STAIN

Composition; weight fraction

Solvent: 0.7867

Resin: 0.2133

Pigment:

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	77.7
Aromatic hydrocarbons	Toluene	0.375	12.8
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	0.1
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		90.6

Table A-20. TYPE OF SURFACE COATING: GLAZE

Composition; weight fraction

Solvent: 0.5322

Resin: 0.2623

Pigment: 0.2055

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	64.6
Aromatic hydrocarbons	Toluene	0.375	5.6
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	1.3
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		71.5

Table A-21. TYPE OF SURFACE COATING: WASH COAT

Composition; weight fraction

Solvent: 0.9047

Resin:

Pigment: 0.0953

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	43.7
Aromatic hydrocarbons	Toluene	0.375	15.0
Saturated alcohols	n-Propyl alcohol	0.500	10.2
Ketones	Methyl ethyl ketone	0.590	13.0
Saturated esters	n-Butyl acetate	0.710	16.3
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	5.3
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		103.5

Table A-22. TYPE OF SURFACE COATING: SEALER

Composition; weight fraction

Solvent: 0.9130

Resin:

Pigment: 0.0870

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	44.7
Aromatic hydrocarbons	Toluene	0.375	7.2
Saturated alcohols	n-Propyl alcohol	0.500	14.0
Ketones	Methyl ethyl ketone	0.590	18.3
Saturated esters	n-Butyl acetate	0.710	18.9
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		103.1

Table A-23. TYPE OF SURFACE COATING: TOLUENE REPLACEMENT THINNER

Composition; weight fraction

Solvent: 1.000

Resin:

Pigment:

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	68.2
Aromatic hydrocarbons	Toluene	0.375	20.5
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	10.7
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	24.3
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		123.7

Table A-24. TYPE OF SURFACE COATING: XYLENE REPLACEMENT THINNER

Composition; weight fraction

Solvent: 1.000

Resin:

Pigment:

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	69.5
Aromatic hydrocarbons	Toluene	0.375	8.8
Saturated alcohols	n-Propyl alcohol	0.500	24.0
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	16.2
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		118.5

Table A-25. TYPE OF SURFACE COATING: POROUS TEXTILE COATING FOR UPHOLSTERY

Composition; weight fraction

Solvent: 0.6698

Resin: 0.3302

Pigment:

Assumed coverage: 344.0 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	275.5
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	6.85
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		282.35

Table A-26. TYPE OF SURFACE COATING: TEXTILE COATING FOR TRUCK SEATS

Composition; weight fraction

Solvent: 0.6035
Resin: 0.3965
Pigment:

Assumed coverage: 1523 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	318.7
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Chlorinated Hydrocarbons	Perchloroethylene		0.67
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	0.19
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	58.54
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		378.13

Table A-27. TYPE OF SURFACE COATING: FABRIC COATING - SHIRT COLLARS

Composition; weight fraction

Solvent: 0.802

Resin: 0.198

Pigment:

Assumed coverage: 197.9 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	3.92
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		3.92

Table A-28. TYPE OF SURFACE COATING: HEAT SEALABLE FORM-FILL PACKAGING

Composition; weight fraction

Solvent: 0.400

Resin: 0.600

Pigment:

Assumed coverage: 99.3 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	29.8
Acrylic	Methyl methacrylate	0.410	29.8
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		59.6

Table A-29. TYPE OF SURFACE COATING: GLASSINE PAPER COATING

Composition; weight fraction

Solvent: 0.400

Resin: 0.600

Pigment:

Assumed coverage: 66.3 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	3.62
Acrylic	Methyl methacrylate	0.410	0.36
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		3.98

Table A-30. TYPE OF SURFACE COATING: WATER RESISTANT PAPER COATING

Composition; weight fraction

Solvent: 0.375

Resin: 0.625

Pigment:

Assumed coverage: 49.8 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	3.11
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		3.11

Table A-31. TYPE OF SURFACE COATING: GLASSINE HEAT-SEALABLE BARRIER PAPER COATING (HOT MELT)

Composition; weight fraction

Solvent:
Resin: 1.000
Pigment:

Assumed coverage: 76.2 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	3.66
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Paraffin	0.560	3.96
	TOTAL		7.62

Table-32. TYPE OF SURFACE COATING: PAPER COATING WITH IMPROVED PRINTABILITY

Composition; weight fraction

Solvent: 0.400

Resin: 0.600

Pigment:

Assumed coverage: 34.28 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	2.37
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	0.31
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	Ethylene	1.25	0.75
	TOTAL		3.43

Table A-33. TYPE OF SURFACE COATING: PAPER COATING WITH IMPROVED PRINTABILITY

Composition; weight fraction

Solvent: 0.550

Resin: 0.069

Pigment: 0.381

Assumed coverage: 43.9 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Filler	Clay	0.010	3.724
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	0.670
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		4.394

Table A-34. TYPE OF SURFACE COATING: PAPER COATING

Composition; weight fraction

Solvent:	0.130
Resin:	0.070
Filler:	0.800

Assumed coverage: 27.13 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Filler	Clay	0.010	1.30
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	0.33
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		1.63

Table A-35. TYPE OF SURFACE COATING: PAPER COATING

Composition; weight fraction

Solvent: 0.5979

Resin: 0.4021

Pigment:

Assumed coverage: 25.91 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene-butadiene	Styrene	0.420	0.98
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
Styrene	Styrene	0.420	9.44
	TOTAL		10.42

Table A-36. TYPE OF SURFACE COATING: HIGH GLOSS FLEXIBLE CAST COATED PAPER

Composition; weight fraction

Solvent: 0.1631

Resin: 0.4199

Pigment: 0.4170

Assumed coverage: 169.3 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Filler	Clay	0.010	7.06
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	0.74
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene-Butadiene	Styrene	0.420	0.23
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	Casein		5.36
	TOTAL		13.39

Table A-37. TYPE OF SURFACE COATING: SCUFF-RESISTANT RAINWEAR

Composition; weight fraction

Solvent: 0.5039

Resin: 0.4961

Pigment:

Assumed coverage: 100.02 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	2.90
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	47.50
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	0.34
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	3.70
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	0.54
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		54.98

Table A-38. TYPE OF SURFACE COATING: FABRIC COATING FOR IMPROVING TEXTURE

Composition; weight fraction

Solvent: 0.542
Resin: 0.458
Pigment:

Assumed coverage: 204.7 g/m^2

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	9.38
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		9.38

Table A-39. TYPE OF SURFACE COATING: FABRIC DYEING

Composition; weight fraction

Solvent: 1.0000

Resin:

Pigment:

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	4.1
Saturated alcohols	n-Propyl alcohol	0.500	4.1
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Halogenated Hydrocarbon	Perchloroethylene	0.670	32.5
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		40.7

Table A-40. TYPE OF SURFACE COATING: WRINKLE RESISTANT FINISHES

Composition; weight fraction

Solvent:

Resin: 1.0000

Pigment:

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
Melamine	Melamine	0.005	0.292
Formaldehyde	Formaldehyde	0.003	0.409
	TOTAL		0.701

Table A-41. TYPE OF SURFACE COATING: FABRIC SIZING

Composition; weight fraction

Solvent:

Resin: 1.0000

Pigment:

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	0.682
Styrene	Styrene	0.420	0.682
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
Surfactant		0.020	0.027
	TOTAL		1.391

Table A-42. TYPE OF SURFACE COATING: FABRIC WATERPROOFING

Composition; weight fraction

Solvent:

Resin: 1.0000

Pigment:

Assumed coverage: 7.36 m^2/liter (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	0.078
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	0.112
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
	TOTAL		0.190

Table A-43. TYPE OF SURFACE COATING: PAPER BAG COATING

Composition; weight fraction

Solvent:
Resin: 1.0000
Pigment:

Assumed coverage: 7.36 m^2/liter = (300 ft^2/gal)

Emission factors

Component	Major species	TLV, g/m^3	Emission factor, g/m^2
Solvent emissions			
Aliphatic hydrocarbons	Mineral spirits	2.800	
Aromatic hydrocarbons	Toluene	0.375	
Saturated alcohols	n-Propyl alcohol	0.500	
Ketones	Methyl ethyl ketone	0.590	
Saturated esters	n-Butyl acetate	0.710	
Saturated ethers	Ethylene glycol Mono-ethyl ether Acetate	0.120	
Resin emissions			
Alkyd	Phthalic anhydride	0.012	
Vinyl	Vinyl chloride	0.0026	
Acrylic	Methyl methacrylate	0.410	
Epoxy	Epichlorohydrin	0.019	
Urethane	Toluene diioscyanate	0.00014	
Cellulosic	Methyl ethyl ketone	0.590	
Amino	Ethanolamine	0.006	
Rosin ester	Maleic anhydride	0.001	
Styrene	Styrene	0.420	1.01
Phenolic	Phenol	0.012	
Hydrocarbon	Turpentine	0.560	
Butadiene		2.200	1.39
Ethenyloxazoline		0.200	0.46
		TOTAL	2.86

APPENDIX B

PRIORITIZATION INPUT DATA FOR 25 LARGEST SOURCES OF HYDROCARBON EMISSIONS FROM SURFACE COATING

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Table B-1. STATE POPULATION DATA

State code	State	State population density, persons/km^2	State code	State	State population density, persons/km^2
1	Alabama	25.77	26	Montana	1.82
2	Alaska	0.20	27	Nebraska	7.42
3	Arizona	6.01	28	Nevada	1.71
4	Arkansas	13.98	29	New Hampshire	30.61
5	California	48.54	30	New Jersey	353.19
6	Colorado	8.17	31	New Mexico	3.22
7	Connecticut	233.73	32	New York	142.07
8	Delaware	102.88	33	North Carolina	37.31
9	Florida	44.76	34	North Dakota	3.37
10	Georgia	30.10	35	Ohio	99.77
11	Hawaii	46.09	36	Oklahoma	14.13
12	Idaho	3.29	37	Oregon	8.32
13	Illinois	76.08	38	Pennsylvania	100.45
14	Indiana	55.25	39	Rhode Island	302.05
15	Iowa	19.66	40	South Carolina	31.20
16	Kansas	70.81	41	South Dakota	3.34
17	Kentucky	30.77	42	Tennessee	35.86
18	Louisiana	28.76	43	Texas	16.17
19	Maine	11.55	44	Utah	4.81
20	Maryland	143.18	45	Vermont	17.87
21	Massachusetts	266.03	46	Virginia	43.97
22	Michigan	58.86	47	Washington	19.30
23	Minnesota	17.47	48	West Virginia	27.85
24	Mississippi	17.94	49	Wisconsin	30.38
25	Missouri	25.92	50	Wyoming	1.31

Table B-2. PRODUCT: PAPER BAGS

Product: Paper Bags

Category: Paper and Paper Board

Total Production: 7.73×10^{11} units/yr

Average Plant Size: 1.21×10^{10} units/yr

Frequency of Operation: 3 shifts/day

Emissions Data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Styrene	0.420	0.117
Hydrocarbon	0.560	0.132
Ethenyloxazoline	0.200	0.044

Location

State code	No. of plants
1	2
5	4
7	1
13	3
14	1
15	2
17	1
18	1
19	1
21	1
23	2
24	1
25	3
30	4
32	10
33	1
35	2
36	1
37	3
38	5
40	1
42	4
46	2
47	2
48	1
49	5

Table B-3. PRODUCT: METAL CANS - EXCLUDING BEVERAGE CANS

Product: Metal Cans - Excluding Beverage Cans

Category: Sheet, Strip, and Coil

Total Production: 3.98×10^{11} units/yr

Average Plant Size: 4.91×10^{8} units/yr

Frequency of Operation 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.800	0.956
Aromatic Hydrocarbons	0.375	0.785
Saturated alcohols	0.500	0.166
Ketones	0.590	2.657
Saturated esters	0.710	0.269
Saturated ethers	0.120	0.002
Alkyd	0.012	0.073
Vinyl	0.0026	0.055
Acrylic	0.410	0.007
Urethane	0.00014	0.005
Amino	0.006	0.042

Location data

State code	No. of plants
5	5
7	11
13	9
21	1
25	1
30	15
32	12
35	10
37	1
38	11
39	1
43	1
48	1
49	2

Table B-4. PRODUCT: DYEING

Product: Dyeing

Category: Fabric Treatment

Total Production: 4.787×10^9 units/yr

Average Plant Size: 1.17×10^8 units/yr

Frequency of Operation 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aromatic hydrocarbons	0.375	4.00
Saturated alcohols	0.500	4.00
Chlorinated hydrocarbons	0.670	31.76

Location data

State code	No. of plants
1	1
7	1
8	1
10	6
13	3
17	1
21	6
25	1
30	3
32	6
33	5
38	2
39	1
40	3
42	1

Table B-5. PRODUCT: BEVERAGE CANS

Product: Beverage Cans

Category: Sheet, Strip, and Coil

Total Production: 3.74×10^{10} units/yr

Average Plant Size 6.23×10^{9} units/yr

Frequency of Operation: 3 shifts/day

Location data

State code	No. of plants
13	1
32	1
35	1
38	3

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.800	0.956
Aromatic hydrocarbons	0.375	0.785
Saturated alcohols	0.500	0.166
Ketones	0.590	2.657
Saturated esters	0.710	0.269
Saturated ethers	0.120	0.002
Alkyd	0.012	0.073
Vinyl	0.0026	0.055
Acrylic	0.410	0.007
Urethane	0.00014	0.005
Amine	0.006	0.042

Table B-6. PRODUCT: KRAFT PAPER

Product: Kraft Paper

Category: Paper and Paper Board

Total Production: 1.416×10^{10} units/yr

Average Plant Size: 3.455×10^{8} units/yr

Frequency of Operation: 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Styrene	0.420	4.99

Location data

State code	No. of plants
4	1
5	1
13	3
15	1
18	2
21	1
22	2
23	2
30	3
32	5
33	1
35	7
37	3
39	1
43	1
45	1
46	2
49	4

Table B-7. PRODUCT: COATED PAPER - EXCLUDING WAXED

Product: Coated Paper - Excluding Waxed

Category: Paper and Paper Board

Total Production: 1.89 x 10^{11} units/yr

Average Plant Size: 3.44 x 10^{9} units/yr

Frequency of Operation: 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Vinyl	0.0026	0.337
Acrylic	0.410	0.0335

Location data

State code	No. of plants
5	3
7	1
13	5
18	1
19	1
21	7
22	3
23	2
30	8
32	5
35	5
38	5
46	2
47	1
49	6

Table B-8. PRODUCT: PRINTING PAPER

Product: Printing Paper

Category: Paper and Paper Board

Total Production: 8.24×10^{11} units/yr

Average Plant Size: 1.92×10^{9} units/yr

Frequency of Operation: 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Vinyl	0.0026	0.062

Location data

State code	No. of plants
6	1
13	3
19	2
21	2
22	6
23	1
29	2
30	3
32	8
33	1
35	5
37	2
38	3
47	1
49	3

Table B-9. PRODUCT: DUCTWORK

Product: Ductwork

Category: Sheet, Strip, and Coil

Total Production: 2.60×10^6 units/yr

Average Plant Size: 5.20×10^4 units/yr

Frequency of Operation: 2 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.800	3112.0
Aromatic hydrocarbons	0.375	2556.0
Saturated alcohols	0.500	539.7
Ketones	0.590	8650.0
Saturated esters	0.710	875.7
Saturated ethers	0.120	6.30
Alkyd	0.012	237.3
Vinyl	0.0026	180.6
Acrylic	0.410	23.10
Urethane	0.00014	16.80
Amino	0.006	136.50

Location data

State code	No. of plants
1	1
5	1
6	1
7	3
8	1
9	1
13	5
14	4
18	1
22	2
25	2
27	1
30	2
32	7
33	2
35	8
36	1
38	3
42	1
43	1
46	1
49	1

Table B-10. PRODUCT: OILED AND WAXED PAPER

Product: Oiled and Waxed Paper

Category: Paper and Paper Board

Total Production: 9.80×10^8 units/yr

Average Plant Size: 2.79×10^5 units/yr

Frequency of Operation: 3 shifts/day

Emissions data		
Material emitted	TLV, g/m^3	Emission factor, g/unit
Vinyl	0.0026	13.7
Hydrocarbon	0.560	11.0
Poly(1-butene)	2.680	13.7

Location data	
State code	No. of plants
5	1
7	1
9	1
13	4
14	1
15	1
18	1
21	1
22	2
23	1
25	1
29	1
30	2
32	3
35	4
37	1
38	4
43	1
46	1
47	1
49	3

Table B-11. PRODUCT: MILK CARTON BOARD

Product: Milk Carton Board

Category: Paper and Paper Board

Total Production: 5.54×10^9 units/yr

Average Plant Size: 8.16×10^7 units/yr

Frequency of Operation: 3 shifts/day

Emissions data		
Material emitted	TLV, g/m^3	Emission factor, g/unit
Vinyl	0.0026	2.19
Acrylic	0.410	2.19

Location data	
State code	No. of plants
5	3
7	1
13	5
18	1
19	1
21	7
22	3
23	2
30	8
32	5
35	5
38	5
46	2
47	1
49	6

Table B-12. PRODUCT: PAPER BOXES

Product: Paper Boxes
Category: Paper and Paper Boxes
Total Production: 1.07×10^{12} units/yr
Average Plant Size: 6.73×10^{9} units/yr
Frequency of Operation: 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Vinyl	0.0026	0.0153

Location data

State code	No. of plants
4	2
5	10
7	10
9	2
10	2
12	1
13	18
14	8
15	1
17	2
18	1
20	4
21	8
22	3
23	4
25	6
27	2
30	12
32	30
33	2
35	9
36	1
37	1
38	8
39	2
40	2
42	1
43	2
46	1
49	4

Table B-13. PRODUCT: WOOD PANELING

Product: Wood Paneling

Category: Sheet, Strip, and Coil

Total Production: 1.80×10^9 units/yr

Average Plant Size: 4.86×10^7 units/yr

Frequency of Operation: 1 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	1.38
Aromatic hydrocarbons	0.375	1.13
Saturated alcohols	0.500	0.24
Ketones	0.590	3.83
Saturated esters	0.710	0.39
Saturated ethers	0.120	.003
Alkyd	0.012	0.10
Vinyl	0.0026	0.08
Acrylic	0.410	0.10
Urethane	0.00014	0.007
Amino	0.006	0.60

Location data

State code	No. of plants
5	3
13	1
16	1
17	1
18	2
19	1
22	2
23	2
25	1
30	1
32	9
33	1
35	2
37	5
38	3
41	1
42	1

Table B-14. PRODUCT: CANOPIES AND AWNINGS

Product: Canopies and Awnings

Category: Sheet, Strip and Coil

Total Production: 1.50×10^6 units/yr

Average Plant Size: 6.00×10^4 units/yr

Frequency of Operation: 2 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	1556.
Aromatic hydrocarbons	0.375	1278.
Saturated alcohols	0.500	269.8
Ketones	0.590	4325.
Saturated esters	0.710	437.9
Saturated ethers	0.120	3.20
Alkyd	0.012	118.6
Vinyl	0.0026	90.3
Acrylic	0.410	11.6
Urethane	0.00014	8.4
Amino	0.006	68.2

Location data

State code	No. of plants
1	1
4	1
5	2
9	1
13	1
16	1
18	2
20	2
21	1
22	3
23	1
27	1
30	1
33	1
35	2
38	2
43	1
46	1

Table B-15. PRODUCT: SIZING

Product: Sizing

Category: Fabric Treatment

Total Production: 1.09×10^{10} units/yr

Average Plant Size: 7.08×10^{7} units/yr

Frequency of Operation: 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Rosin ester	0.001	0.489
Styrene	0.420	0.489

Location data

State code	No. of plants
1	6
5	1
7	4
10	23
13	3
14	1
15	1
18	1
19	3
20	3
21	6
23	2
25	1
29	3
32	29
33	23
35	5
38	3
39	3
40	27
42	5
43	1

Table B-16. PRODUCT: REFRIGERATORS

Product: Refrigerators
Category: Major Appliances
Total Production: 6.315×10^6 units/yr
Average Plant Size: 3.007×10^5 units/yr
Frequency of Operation: 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliqhatic hydrocarbons	2.80	529.2
Aromatic hydrocarbons	0.375	111.2
Saturated alcohols	0.500	79.7
Ketones	0.590	120.0
Saturated esters	0.710	109.6
Saturated ethers	0.120	80.7
Alkyd	0.012	5.10
Vinyl	0.0026	3.0
Acrylic	0.410	2.8

Location data

State code	No. of plants
13	1
14	1
15	1
17	1
22	3
24	1
30	1
32	2
35	3
38	2
43	1
49	4

Table B-17. PRODUCT: FOLDING CARTONS

Product: Folding Cartons
Category: Paper and Paper Board
Total Production: 1.432×10^9 units/yr
Average Plant Size: 9.01×10^7 units/yr
Frequency of Operation: 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Vinyl	0.0026	3.24

Location data

State code	No. of plants
4	2
5	10
7	10
9	2
10	2
12	1
13	18
14	8
15	1
17	2
18	1
20	4
21	8
22	3
23	4
25	6
27	2
30	12
32	30
33	2
35	9
36	1
37	1
38	8
39	2
40	2
42	1
43	2
46	1
49	4

Table B-18. PRODUCT: SCREENING

Product: Screening

Category: Sheet, Strip, and Coil

Total Production: 5.77×10^8 units/yr

Average Plant Size: 1.56×10^7 units/yr

Frequency of Operation: 2 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	1.38
Aromatic hydrocarbons	0.375	1.13
Saturated alcohols	0.500	0.24
Ketones	0.590	3.83
Saturated esters	0.710	0.39
Saturated ethers	0.120	0.003
Alkyd	0.012	0.10
Vinyl	0.0026	0.08
Acrylic	0.410	0.10
Urethane	0.00014	0.007
Amino	0.006	0.60

Location data

State code	No. of plants
5	1
7	1
9	1
13	2
17	1
20	2
22	3
25	1
30	6
32	4
35	3
37	1
38	5
39	1
40	1
42	1
43	1
47	1
49	1

Table B-19. PRODUCT: FENCING

Product: Fencing

Category: Sheet, Strip and Coil

Total Production: 5.51×10^5 units/yr

Average Plant Size: 2.21×10^4 units/yr

Frequency of Operation: 2 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	1482.
Aromatic hydrocarbons	0.375	1217.
Saturated alcohols	0.500	257.
Ketones	0.590	4119.
Saturated esters	0.710	417.
Saturated ethers	0.120	3.0
Alkyd	0.012	113.
Vinyl	0.0026	36.
Acrylic	0.410	11.
Urethane	0.00014	8.0
Amino	0.006	65.0

Location data

State code	No. of plants
1	1
6	1
7	1
13	4
14	1
17	1
20	2
21	2
22	1
30	3
32	3
36	1
38	4
49	1

Table B-20. PRODUCT: BEDROOM FURNITURE

Product: Bedroom Furniture
Category: Wood Furniture
Total Production: 1.69×10^7 units/yr
Average Plant Size: 1.99×10^5 units/yr
Frequency of Operation: 2 shifts/day

Emissions data		
Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	129.0
Aromatic hydrocarbons	0.375	22.4
Saturated alcohols	0.500	20.7
Ketones	0.590	3.7
Saturated esters	0.710	27.2
Saturated ethers	0.120	17.8
Alkyd	0.012	2.8

Location data	
State code	No. of plants
4	6
5	3
9	1
10	2
14	5
17	1
20	1
22	6
23	1
24	1
25	2
29	1
32	11
33	16
35	1
36	1
37	1
38	3
40	4
42	4
43	2
45	2
46	9
47	1

Table B-21. PRODUCT: ENAMELED PLUMBING FIXTURES

Product: Enameled Plumbing Fixtures
Category: Major Appliances
Total Production: 1.40×10^7 units/yr
Average Plant Size: 6.66×10^5 units/yr
Frequency of Operation: 3 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	127.7
Aromatic hydrocarbons	0.375	20.7
Saturated alcohols	0.500	15.8
Saturated esters	0.710	17.8
Saturated ethers	0.120	16.0
Alkyd	0.012	2.6

Location data

State code	No. of plants
5	3
13	1
15	3
23	1
30	2
32	7
35	1
38	1
43	1
49	1

Table B-22. PRODUCT: DRYERS

Product: Dryers
Category: Major Appliances
Total Production: 3.92×10^6 units/yr
Average Plant Size: 2.31×10^5 units/yr
Frequency of Operation: 3 shifts/day

Emissions data		
Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.800	336.0
Aromatic hydrocarbons	0.375	107.8
Saturated alcohols	0.500	52.2
Ketones	0.590	45.2
Saturated esters	0.710	74.1
Saturated ethers	0.120	54.7
Alkyd	0.012	1.9
Vinyl	0.0026	1.1
Acrylic	0.410	1.1
Epoxy	0.019	13.6

Location data	
State code	No. of plants
5	1
13	1
15	2
17	2
22	1
30	1
32	1
35	4
38	1
49	3

Table B-23. PRODUCT: WASHERS

Product: Washers

Category: Major Appliances

Total Production: 5.11×10^6 units/yr

Average Plant Size: 3.19×10^5 units/yr

Frequency of Operation: 3 shifts/day

Location data	
State code	No. of plants
15	3
17	1
22	1
32	3
35	5
38	1
49	2

Emissions data		
Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	250.8
Aromatic hydrocarbons	0.375	80.5
Saturated alcohols	0.500	38.9
Ketones	0.590	33.7
Saturated esters	0.710	55.4
Saturated ethers	0.120	40.8
Alkyd	0.012	1.4
Vinyl	0.0026	0.8
Acrylic	0.410	0.8
Epoxy	0.019	10.2

Table B-24. PRODUCT: FILING CABINETS

Product: Filing Cabinets

Category: Metal Furniture

Total Production: 3.77×10^6 units/yr

Average Plant Size: 5.39×10^4 units/yr

Frequency of Operation: 2 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphated hydrocarbons	2.80	386.6
Aromatic hydrocarbons	0.375	79.0
Saturated alcohols	0.500	52.9
Ketones	0.590	46.6
Saturated esters	0.710	58.7
Saturated ethers	0.120	53.6
Alkyd	0.012	5.9
Vinyl	0.0026	1.0
Acrylic	0.410	0.10

Location data

State code	No. of plants
5	2
10	1
13	11
14	2
15	2
16	1
17	2
21	1
22	4
23	2
25	1
30	2
32	18
35	6
38	11
47	1
49	3

Table B-25. PRODUCT: METAL DOORS - EXCLUDING GARAGE DOORS

Product: Metal Doors - Excluding Garage Doors

Category: Sheet, Strip, and Coil

Total Production: 6.97×10^6 units/yr

Average Plant Size: 1.34×10^5 units/yr

Frequency of Operation: 2 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	63.0
Aromatic hydrocarbons	0.375	51.7
Saturated alcohols	0.500	10.9
Ketones	0.590	175.1
Saturated esters	0.710	17.7
Saturated ethers	0.120	0.10
Alkyd	0.012	4.8
Vinyl	0.0026	3.7
Acrylic	0.410	0.5
Urethane	0.00014	0.3
Amino	0.006	2.8

Location data

State code	No. of plants
1	1
13	7
14	2
15	1
17	2
21	2
22	4
23	2
25	2
30	1
32	7
33	1
35	8
38	4
42	2
43	2
46	1
47	2
49	1

Table B-26. PRODUCT: GUTTERS

Product: Gutters

Category: Sheet, Strip and Coil

Total Production: 1.39×10^5 units/yr

Average Plant Size: 4.63×10^3 units/yr

Frequency of Operation: 2 shifts/day

Emissions data

Material emitted	TLV, g/m^3	Emission factor, g/unit
Aliphatic hydrocarbons	2.80	3112.
Aromatic hydrocarbons	0.375	2556.
Saturated alcohols	0.500	539.7
Ketones	0.590	8650.
Saturated esters	0.710	875.7
Saturated ethers	0.120	6.3
Alkyd	0.012	237.3
Vinyl	0.0026	180.6
Acrylic	0.410	23.1
Urethane	0.00014	16.8
Amino	0.006	136.5

Location data

State code	No. of plants
1	1
5	4
13	3
14	1
15	1
22	2
30	1
32	1
35	5
38	7
46	2
48	1
49	1

APPENDIX C

PRIORITIZATION OUTPUT DATA

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Table C-1. MAJOR APPLIANCE FINISHING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	REFRIGERATORS	2,000	B
2	ENAMELED PLUMBING FIXTURES	1,000	B
3	RADIOS AND TELEVISIONS	1,000	B
4	DRYERS	1,000	B
5	WASHERS	900	B
6	FREEZERS	700	B
7	STOVES	700	B
8	WATER HEATERS	600	B
9	AIR CONDITIONERS	400	B
10	FURNACES	300	B
11	DISHWASHERS	300	B
12	LAWN MOWERS	100	B
13	HUMIDIFIERS	90	B
14	DEHUMIDIFIERS	50	B
15	TRASH COMPACTORS	20	B
16	WATER SOFTENERS	20	B
	TOTAL	10,000	

Table C-2. SMALL APPLIANCE FINISHING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	ELECTRIC FANS	3,000	B
2	LAMPS	1,000	B
3	CARPET CARE APPLIANCES	600	B
4	ELECTRIC TOOLS	500	B
5	COFFEE POTS	400	B
6	BATHROOM SCALES	300	B
7	PHONOGRAPHS	300	B
8	SEWING MACHINES	300	B
9	ELECTRIC COOKWARE	200	B
10	BLENDERS	200	B
11	PROJECTORS - MOVIE AND SLIDE	200	B
12	MIXERS	200	B
13	SPACE HEATERS	100	B
14	IRONS	100	B
15	GARBAGE DISPOSALS	100	B
16	CAMERAS	60	B
17	SNOW BLOWERS	50	B
18	TOASTERS	40	C
19	ELECTRIC RAZORS	40	B
20	CAN OPENERS AND KNIFE SHARPENERS	20	B
21	TAPE RECORDERS	20	C
22	HAIR DRYERS	20	C
	TOTAL	8,000	

Table C-3. FARM MACHINERY FINISHING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	BOXES AND RACKS	200	B
2	FARM WAGONS	100	B
3	HAND SPRAYERS	80	B
4	FARM ELEVATORS - PORTABLE	80	B
5	TRACTORS	70	B
6	POULTRY FEEDERS	50	C
7	COMBINES	50	B
8	BROODERS	40	B
9	STACK SHREDDERS	30	B
10	FORAGE BLOWERS	30	B
11	HOG FEEDING EQUIPMENT	20	B
12	NESTS AND CAGES	20	B
13	TURKEY FEEDERS	20	B
14	MANURE SPREADERS	10	B
15	BALE THROWING ATTACHMENTS	10	B
16	BROADCAST SEEDERS	10	B
17	DAIRY MACHINES	10	B
18	FERTILIZER DISTRIBUTORS	9	B
19	HAND DUSTERS	9	B
20	OTHER SPRAYERS - NON-TRACTOR	7	B
21	FIELD FORAGE HARVESTORS	7	B
22	DRYERS	6	B
23	FOGGERS AND MIST SPRAYERS	5	B
24	POWER SPRAYERS	5	B
25	ROTARY CULTIVATORS	5	B
26	HOG WATERING EQUIPMENT	5	B
27	BLADE TERRACERS	5	B
28	MOWER-CONDITIONERS	4	B
29	INCUBATORS	4	B
30	PEANUT COMBINES	4	B
31	FARM ELEVATORS - STATIONARY	3	B
32	MOWERS	3	B
33	HARROWS	3	B
34	HAY BALERS	3	B
35	FEED GRINDERS	3	B
36	HAY CONDITIONERS	2	B
37	CORN AND COTTON CULTIVATORS	2	B
38	MOLDBOARD PLOWS	2	B
39	FIELD CULTIVATORS	2	B
40	AIR-CARRIED TYPE POWER SPRAYER	2	B
41	WINDROWERS - HAY	2	B
42	HAY STACKING ATTACHMENTS	1	B
43	CORN SHELLERS	1	C
44	CORN PICKERS	1	B
45	CORN PLNTRS, LISTERS, POTATO PLNTRS, TRN	1	B
46	FRONT AND REAR MOUNTED LOADERS	1	B
47	PEANUT DIGGERS	1	B
48	LAND LEVELERS	1	B
49	HAY BALE LOADERS	1	B
50	MANURE PUMPS	1	B
51	RAKES	1	B
52	COTTON STRIPPERS	1	B
53	GRAIN DRILLS	1	C
54	FEED MIXERS	1	B
55	POWER DUSTERS	1	B
56	SUBSOILERS - DEEP TILLAGE	1	B
57	MIDDLEBUSTERS AND DISC BEDDERS	1	B
58	CHISEL PLOWS	1	B
59	BEET HARVESTORS	1	B
60	TERRACING AND DITCHING PLOWS	1	B
61	TOBACCO CURERS	1	B
62	POTATO HARVESTORS	1	B
63	WINDROWERS OR SWATHERS	1	B
64	TURKEY WATERERS	1	C
65	ROD WEEDERS	1	B
66	BEET, BEAN, AND VEGETABLE CULTIVATORS	1	B
67	DISC PLOWS	1	B
68	EGG GRADERS	1	B
69	EGG WASHERS	1	B
	TOTAL	1,000	

Table C-4. INDUSTRIAL MACHINERY FINISHING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	SPINNING FRAMES	1.000	B
2	PUMPS	900	B
3	COMPRESSORS	800	B
4	TWISTING FRAMES	600	B
5	ROTARY DRILLING EQUIPMENT - SUBSURFACE	200	B
6	AUTOMOTIVE MAINTENANCE EQUIPMENT	200	C
7	SAWING MACHINES - WOOD	200	B
8	GRINDING AND POLISHING MACHINES	80	B
9	BLEACHING, DRYING, FINISHING MACHINERY	70	C
10	PACKING, PACKAGING, BOTTLING MACHINERY	70	B
11	REBUILT PULP AND PAPERMILL MACHINERY	60	C
12	LATHES, PLANERS, ETC. - WOOD	60	C
13	PRESSES - METAL	50	B
14	CHOPPERS, GRINDERS, CUTTERS, ETC. - FOOD	50	B
15	WELDING AND CUTTING APPARATUS	50	C
16	INDUSTRIAL TRUCKS	40	B
17	PUNCHING AND SHEARING MACHINES	40	B
18	DRILLING MACHINES	30	B
19	BENDING AND FORMING MACHINES	30	B
20	FLOWING WELL EQUIPMENT	30	C
21	WOOD PREPARATION EQUIPMENT - PULPMILLS	30	C
22	METAL CLEANING MACHINERY	20	C
23	KNITTING MACHINES	20	B
24	CHEMICAL MANUFACTURING INDUSTRIAL MACH	20	C
25	FRUIT AND VEGETABLE CANNING MACHINERY	20	C
26	LATHES - METAL	20	B
27	JOINTERS	20	C
28	MEAT AND POULTRY PROCESSING MACHINERY	20	C
29	PLASTICS WORKING MACHINERY	20	B
30	CEMENT MAKING MACHINERY	20	C
31	HOISTS	20	B
32	CHAIN SAWS	10	B
33	ROD LIFTING MACHINERY - OIL	10	C
34	PAPER AND PAPERBOARD CONVERTING MACHINER	10	B
35	COTTON GINNING MACHINERY	10	C
36	MINE CARS, TRACK	10	B
37	SUGAR PLANT PROCESSING MACHINERY	10	C
38	MILLING MACHINES	9	B
39	TYPESETTING MACHINERY	8	B
40	YARN PREPARING MACHINES	8	B
41	SAWMILL EQUIPMENT	8	C
42	TOBACCO MANUFACTURING MACHINES	7	B
43	SCREENS - MINING	7	B
44	CLAYWORKING MACHINER	7	C
45	OFF-SET LITHOGRAPHIC PRESSES	6	B
46	CONSTRUCTION CRANES	5	B
47	SAWING AND CUTOFF MACHINES - METAL	5	B
48	FEEDERS	5	B
49	CLEANING AND OPENING MACHINES	5	B
50	OVERHEAD CRANES	5	B
51	SHOEMAKING MACHINERY	5	C
52	MOTORIZED HAND TRUCKS	5	B
53	CRUSHERS	5	B
54	PAPERMILL MACHINERY	4	B
55	EXCAVATORS	4	B
56	PLANERS - METAL	4	C

Table C-4 (Cont.) INDUSTRIAL MACHINERY FINISHING: OPTION 1

57	HOT ROLLING MILL MACHINES	3	C
58	ICE CREAM FREEZERS	3	C
59	CONCRETE PRODUCT MACHINERY	3	B
60	SHUTTLE CARS - MINING	3	B
61	FLOUR AND GRAIN MILL MACHINERY	3	C
62	COLD ROLLING MILL MACHINES	3	C
63	FLOTATION MACHINES	2	B
64	GLASS MAKING MACHINERY	2	B
65	GEAR CUTTING MACHINES	2	B
66	CLASSIFIERS	2	B
67	LETTERSET PRINTING PRESSES	2	B
68	BINDERY EQUIPMENT	2	B
69	LOADING, CUTTING, LONGWALL MINING MACH	2	B
70	DRILLS - MINING	2	B
71	FOUNDRY MACHINERY	2	C
72	VENEER AND PLYWOOD EQUIPMENT	2	C
73	CARDING AND COMBING MACHINES	1	B
74	ELECTRONIC TUBE MANUFACTURING MACHINERY	1	C
75	PULPMILL MACHINERY	1	B
76	GRINDING MILLS	1	B
77	MAGNETIC SEPARATORS	1	B
78	HOMOGENIZERS AND PASTEURIZERS	1	B
79	CENTRIFUGAL DRIERS	1	B
80	CONCRETE MIXERS	1	B
81	BAKERY MACHINERY	1	B
82	TAPPING MACHINES	1	B
83	BORING MACHINES	1	B
84	CONTINUOUS MINING MACHINES	1	B
85	WET CYCLONES - MINING	1	B
86	BUTTER AND CHEESE PROCESSING MACHINERY	1	B
87	SCRUBBERS - MINING	1	B
88	GRAVURE PRINTING PRESSES	1	B
89	THERMAL DRIERS - MINING	1	B
90	CONCENTRATING TABLES	1	B
91	FLEXOGRAPHIC PRINTING PRESSES	1	B
92	BROACHING MACHINES	1	B
93	ROTARY DRILLING EQUIPMENT - SURFACE	1	B
94	WASHING AND STERILIZING EQUIPMENT	1	C
95	SHAPERS - METAL	1	B
	TOTAL	5,000	

Table C-5. COMMERCIAL MACHINERY FINISHING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	VENDING MACHINES	400	B
2	TYPEWRITERS	200	B
3	MAILING AND PARCEL POST SCALES	100	B
4	DUPLICATING MACHINES	70	B
5	ADDING MACHINES	50	B
6	INDUSTRIAL WATER SOFTENERS	40	B
7	GASOLINE PUMPS	30	B
8	MAILING MACHINES	30	B
9	TIME RECORDERS	30	B
10	COMMERCIAL DISHWASHERS	20	B
11	MOTOR TRUCK SCALES	10	B
12	FORMS HANDLING EQUIPMENT	10	B
13	CHECK HANDLING MACHINES	10	B
14	CASH REGISTERS	10	B
15	DICTATING MACHINES	8	C
16	ACCOUNTING MACHINES	6	B
17	COMMERCIAL FLOOR WAXERS	6	C
18	RETAIL AND COMMERCIAL SCALES	4	B
19	COMMERCIAL CARPET SWEEPERS	3	B
20	ELECTRONIC CALCULATORS	1	B
	TOTAL	1,000	

Table C-6. WOOD FURNITURE FINISHING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	BEDROOM FURNITURE	1,000	B
2	TABLES	1,000	B
3	CABINETS	1,000	B
4	CHAIRS	400	B
5	DESKS	200	B
6	BOOKCASES	60	B
	TOTAL	4,000	

Table C-7. SHEET, STRIP, AND COIL COATING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	METAL CANS - EXCLUDING BEVERAGE CANS	900,000	B
2	BEVERAGE CANS	500,000	B
3	DUCTWORK	200,000	C
4	WOOD PANELING	100,000	C
5	SCREENING	40,000	B
6	CANOPIES AND AWNINGS	40,000	C
7	FENCING	20,000	B
8	BEER AND SOFT DRINK BOTTLE CAPS	10,000	B
9	GUTTERS	7,000	B
10	METAL DOORS - EXCLUDING GARAGE DOORS	7,000	B
11	ALUMINUM SIDING AND ROOFING	4,000	B
12	DOOR AND WINDOW FRAMES	3,000	B
13	GARAGE DOORS	3,000	B
14	RAILINGS, FIRE ESCAPES, STAIRCASES	1,000	B
15	SHELVING	200	C
16	WIRE PRODUCTS	90	C
17	STEEL SHIPPING BARRELS	70	B
	TOTAL	2,000,000	

Table C-8. METAL FURNITURE FINISHING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	FILING CABINETS	1,000	B
2	DESKS	900	B
3	TABLES	700	B
4	CHAIRS	600	B
5	COAT RACKS	300	C
6	SAFES AND VAULTS	200	B
7	CABINETS	200	C
8	WASTE CANS	80	C
9	BOOK CASES	10	B
	TOTAL	4,000	

Table C-9. PAPER AND PAPERBOARD COATING: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	PAPER BAGS	500,000	B
2	COATED PAPER - EXCLUDING WAXED	400,000	B
3	KRAFT PAPER	300,000	B
4	PRINTING PAPER	200,000	B
5	MILK CARTON BOARD	100,000	B
6	OILED AND WAXED PAPER	90,000	B
7	PAPER BOXES	90,000	B
8	FOLDING CARTONS	30,000	B
9	PAPER CANS, TUBES, DRUMS	8,000	B
	TOTAL	2,000,000	

Table C-10. FABRIC TREATMENT: OPTION 1

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	DYEING	900,000	C
2	SIZING	30,000	C
3	WRINKLE RESISTANT FINISHES	4,000	C
4	PERMANENT CRISPNESS	1,000	C
5	WATER PROOF AND WATER REPELLENT FINISHES	50	C
	TOTAL	900,000	

Table C-11. MAJOR APPLIANCE FINISHING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	REFRIGERATORS	10,000	B
2	ENAMELED PLUMBING FIXTURES	9,000	B
3	RADIOS AND TELEVISIONS	6,000	B
4	DRYERS	5,000	B
5	WASHERS	5,030	B
6	STOVES	5,000	B
7	FREEZERS	4,000	B
8	WATER HEATERS	4,000	B
9	AIR CONDITIONERS	2,000	B
10	FURNACES	2,000	B
11	DISHWASHERS	2,000	B
12	LAWN MOWERS	800	B
13	HUMIDIFIERS	500	B
14	DEHUMIDIFIERS	300	B
15	TRASH COMPACTORS	100	B
16	WATER SOFTENERS	100	B
	TOTAL	60,000	

Table C-12. SMALL APPLIANCE FINISHING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	ELECTRIC FANS	4,000	B
2	LAMPS	1,000	B
3	CARPET CARE APPLIANCES	1,000	B
4	PHONOGRAPHS	500	B
5	SEWING MACHINES	500	B
6	BATHROOM SCALES	500	B
7	COFFEE POTS	400	B
8	ELECTRIC TOOLS	400	B
9	PROJECTORS - MOVIE AND SLIDE	300	B
10	ELECTRIC COOKWARE	300	B
11	MIXERS	300	B
12	BLENDERS	200	B
13	SPACE HEATERS	200	B
14	GARBAGE DISPOSALS	200	B
15	IRONS	100	B
16	CAMERAS	100	B
17	SNOW BLOWERS	100	B
18	TOASTERS	60	C
19	ELECTRIC RAZORS	50	B
20	TAPE RECORDERS	30	C
21	HAIR DRYERS	20	C
22	CAN OPENERS AND KNIFE SHARPENERS	20	B
	TOTAL	10,000	

Table C-13. FARM MACHINERY FINISHING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	BOXES AND RACKS	1,000	B
2	FARM WAGONS	1,000	B
3	FARM ELEVATORS - PORTABLE	600	B
4	HAND SPRAYERS	600	B
5	TRACTORS	500	B
6	POULTRY FEEDERS	400	C
7	COMBINES	400	B
8	STACK SHREDDERS	200	B
9	FORAGE BLOWERS	200	B
10	HOG FEEDING EQUIPMENT	200	B
11	NESTS AND CAGES	100	B
12	TURKEY FEEDERS	100	B
13	BROODERS	90	B
14	MANURE SPREADERS	80	B
15	BALE THROWING ATTACHMENTS	80	B
16	BROADCAST SEEDERS	70	B
17	DAIRY MACHINES	70	B
18	FERTILIZER DISTRIBUTORS	70	B
19	HAND DUSTERS	60	B
20	OTHER SPRAYERS - NON-TRACTOR	50	B
21	FIELD FORAGE HARVESTORS	50	B
22	DRYERS	50	B
23	FOGGERS AND MIST SPRAYERS	40	B
24	POWER SPRAYERS	40	B
25	ROTARY CULTIVATORS	40	B
26	HOG WATERING EQUIPMENT	30	B
27	BLADE TERRACERS	30	B
28	MOWER-CONDITIONERS	30	B
29	INCUBATORS	30	B
30	PEANUT COMBINES	30	B
31	FARM ELEVATORS - STATIONARY	20	B
32	MOWERS	20	B
33	FEED GRINDERS	20	B
34	HAY BALERS	20	B
35	HARROWS	20	B
36	HAY CONDITIONERS	20	B
37	CORN AND COTTON CULTIVATORS	20	B
38	MOLDBOARD PLOWS	10	B
39	FIELD CULTIVATORS	10	B
40	AIR-CARRIED TYPE POWER SPRAYER	10	B
41	WINDROWERS - HAY	10	B
42	HAY STACKING ATTACHMENTS	10	B
43	CORN SHELLERS	10	C
44	CORN PICKERS	8	B
45	CORN PLNTRS, LISTERS, POTATO PLNTRS, TRN	6	B
46	FRONT AND REAR MOUNTED LOADERS	5	B
47	PEANUT DIGGERS	5	B
48	HAY BALE LOADERS	3	B
49	MANURE PUMPS	3	B
50	RAKES	3	B
51	COTTON STRIPPERS	2	B
52	GRAIN DRILLS	2	C
53	FEED MIXERS	2	B
54	POWER DUSTERS	2	B
55	SUBSOILERS - DEEP TILLAGE	2	B
56	MIDDLEBUSTERS AND DISC BEDDERS	2	B
57	BEET HARVESTORS	1	B
58	CHISEL PLOWS	1	B
59	TERRACING AND DITCHING PLOWS	1	B
60	TOBACCO CURERS	1	B
61	POTATO HARVESTORS	1	B
62	LAND LEVELERS	1	B
63	WINDROWERS OR SWATHERS	1	B
64	TURKEY WATERERS	1	C
65	ROD WEEDERS	1	B
66	BEET, BEAN, AND VEGETABLE CULTIVATORS	1	B
67	DISC PLOWS	1	B
68	EGG WASHERS	1	B
69	EGG GRADERS	1	B
	TOTAL	7,000	

Table C-14. INDUSTRIAL MACHINERY FINISHING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	PUMPS	9,000	B
2	SPINNING FRAMES	8,000	B
3	COMPRESSORS	6,000	B
4	TWISTING FRAMES	4,000	B
5	AUTOMOTIVE MAINTENANCE EQUIPMENT	2,000	C
6	ROTARY DRILLING EQUIPMENT - SUBSURFACE	2,000	B
7	SAWING MACHINES - WOOD	1,000	B
8	BLEACHING, DRYING, FINISHING MACHINERY	700	C
9	PACKING, PACKAGING, BOTTLING MACHINERY	700	B
10	REBUILT PULP AND PAPERMILL MACHINERY	600	C
11	GRINDING AND POLISHING MACHINES	600	B
12	CHOPPERS, GRINDERS, CUTTERS, ETC. - FOOD	500	B
13	LATHES, PLANERS, ETC. - WOOD	400	C
14	PRESSES - METAL	400	B
15	WELDING AND CUTTING APPARATUS	300	C
16	INDUSTRIAL TRUCKS	300	B
17	PUNCHING AND SHEARING MACHINES	300	B
18	DRILLING MACHINES	200	B
19	BENDING AND FORMING MACHINES	200	B
20	FLOWING WELL EQUIPMENT	200	C
21	CHEMICAL MANUFACTURING INDUSTRIAL MACH	200	C
22	WOOD PREPARATION EQUIPMENT - PULPMILLS	200	C
23	METAL CLEANING MACHINERY	200	C
24	FRUIT AND VEGETABLE CANNING MACHINERY	200	C
25	MEAT AND POULTRY PROCESSING MACHINERY	200	C
26	KNITTING MACHINES	200	B
27	CEMENT MAKING MACHINERY	200	C
28	LATHES - METAL	100	B
29	CHAIN SAWS	100	B
30	JOINTERS	100	C
31	PAPER AND PAPERBOARD CONVERTING MACHINER	100	B
32	PLASTICS WORKING MACHINERY	100	B
33	HOISTS	100	B
34	ROD LIFTING MACHINERY - OIL	90	C
35	COTTON GINNING MACHINERY	80	C
36	MINE CARS, TRACK	80	B
37	SUGAR PLANT PROCESSING MACHINERY	80	C
38	MILLING MACHINES	70	B
39	TYPESETTING MACHINERY	60	B
40	YARN PREPARING MACHINES	60	B
41	SAWMILL EQUIPMENT	60	C
42	TOBACCO MANUFACTURING MACHINES	50	B
43	SCREENS - MINING	50	B
44	CLAYWORKING MACHINER	50	C
45	OFF-SET LITHOGRAPHIC PRESSES	50	B
46	PAPERMILL MACHINERY	50	B
47	CONSTRUCTION CRANES	40	B
48	SAWING AND CUTOFF MACHINES - METAL	40	B
49	FEEDERS	40	B
50	CLEANING AND OPENING MACHINES	40	B
51	OVERHEAD CRANES	40	B
52	SHOEMAKING MACHINERY	40	C
53	MOTORIZED HAND TRUCKS	40	B
54	CRUSHERS	30	B
55	ICE CREAM FREEZERS	30	C
56	EXCAVATORS	30	B

Table C-14 (Cont.) INDUSTRIAL MACHINERY FINISHING: OPTION 2

57	PLANERS - METAL	30	C
58	HOT ROLLING MILL MACHINES	30	C
59	CONCRETE PRODUCT MACHINERY	20	B
60	SHUTTLE CARS - MINING	20	B
61	FLOUR AND GRAIN MILL MACHINERY	20	C
62	COLD ROLLING MILL MACHINES	20	C
63	FLOTATION MACHINES	20	B
64	GLASS MAKING MACHINERY	20	B
65	GEAR CUTTING MACHINES	10	B
66	CLASSIFIERS	10	B
67	LETTERSET PRINTING PRESSES	10	B
68	BINDERY EQUIPMENT	10	B
69	LOADING, CUTTING, LONGWALL MINING MACH	10	B
70	DRILLS - MINING	10	B
71	FOUNDRY MACHINERY	10	C
72	VENEER AND PLYWOOD EQUIPMENT	10	C
73	PULPMILL MACHINERY	10	B
74	CARDING AND COMBING MACHINES	10	B
75	ELECTRONIC TUBE MANUFACTURING MACHINERY	9	C
76	GRINDING MILLS	8	B
77	MAGNETIC SEPARATORS	7	B
78	HOMOGENIZERS AND PASTEURIZERS	7	B
79	CENTRIFUGAL DRIERS	7	B
80	CONCRETE MIXERS	7	B
81	BAKERY MACHINERY	6	B
82	TAPPING MACHINES	5	B
83	BORING MACHINES	5	B
84	CONTINUOUS MINING MACHINES	5	B
85	BUTTER AND CHEESE PROCESSING MACHINERY	4	B
86	WET CYCLONES - MINING	4	B
87	SCRUBBERS - MINING	2	B
88	GRAVURE PRINTING PRESSES	2	B
89	THERMAL DRIERS - MINING	2	B
90	CONCENTRATING TABLES	1	B
91	FLEXOGRAPHIC PRINTING PRESSES	1	B
92	BROACHING MACHINES	1	B
93	ROTARY DRILLING EQUIPMENT - SURFACE	1	B
94	WASHING AND STERILIZING EQUIPMENT	1	C
95	SHAPERS - METAL	1	B
	TOTAL	40,000	

Table C-15. COMMERCIAL MACHINERY FINISHING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	VENDING MACHINES	5,000	B
2	TYPEWRITERS	2,000	B
3	MAILING AND PARCEL POST SCALES	800	B
4	DUPLICATING MACHINES	500	B
5	INDUSTRIAL WATER SOFTENERS	400	B
6	GASOLINE PUMPS	200	B
7	MAILING MACHINES	200	B
8	ADDING MACHINES	100	B
9	TIME RECORDERS	100	B
10	MOTOR TRUCK SCALES	100	B
11	FORMS HANDLING EQUIPMENT	100	B
12	COMMERCIAL DISHWASHERS	90	B
13	CHECK HANDLING MACHINES	80	B
14	CASH REGISTERS	60	C
15	DICTATING MACHINES	50	B
16	ACCOUNTING MACHINES	40	C
17	COMMERCIAL FLOOR WAXERS	30	B
18	RETAIL AND COMMERCIAL SCALES	20	B
19	COMMERCIAL CARPET SWEEPERS	9	B
20	ELECTRONIC CALCULATORS	4	B
	TOTAL	9,000	

Table C-16. WOOD FURNITURE FINISHING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	BEDROOM FURNITURE	9,000	B
2	TABLES	8,000	B
3	CABINETS	7,000	B
4	CHAIRS	3,000	B
5	DESKS	1,000	B
6	BOOKCASES	400	B
	TOTAL	30,000	

Table C-17. SHEET, STRIP, AND COIL COATING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	METAL CANS - EXCLUDING BEVERAGE CANS	900,000	B
2	BEVERAGE CANS	500,000	B
3	DUCTWORK	200,000	C
4	WOOD PANELING	80,000	C
5	CANOPIES AND AWNINGS	40,000	C
6	FENCING	20,000	B
7	SCREENING	20,000	B
8	METAL DOORS - EXCLUDING GARAGE DOORS	8,000	B
9	GUTTERS	7,000	B
10	BEER AND SOFT DRINK BOTTLE CAPS	6,000	B
11	ALUMINUM SIDING AND ROOFING	4,000	B
12	GARAGE DOORS	2,000	B
13	DOOR AND WINDOW FRAMES	2,000	B
14	RAILINGS, FIRE ESCAPES, STAIRCASES	1,000	B
15	SHELVING	200	C
16	WIRE PRODUCTS	100	C
17	STEEL SHIPPING BARRELS	[illegible]	B
	TOTAL	2,000,000	

Table C-18. METAL FURNITURE FINISHING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	FILING CABINETS	10,000	B
2	DESKS	7,000	B
3	TABLES	5,000	B
4	CHAIRS	5,000	B
5	COAT RACKS	2,000	C
6	SAFES AND VAULTS	1,000	B
7	CABINETS	1,000	C
8	WASTE CANS	600	C
9	BOOK CASES	80	B
	TOTAL	30,000	

Table C-19. PAPER AND PAPERBOARD COATING: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	COATED PAPER - EXCLUDING WAXED	10,000,000	B
2	PRINTING PAPER	6,000,000	B
3	PAPER BOXES	2,000,000	B
4	MILK CARTON BOARD	2,000,000	B
5	OILED AND WAXED PAPER	1,000,000	B
6	FOLDING CARTONS	700,000	B
7	PAPER CANS, TUBES, DRUMS	200,000	B
8	PAPER BAGS	80,000	B
9	KRAFT PAPER	50,000	B
	TOTAL	20,000,000	

Table C-20. FABRIC TREATMENT: OPTION 2

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	SIZING	1,000,000	C
2	DYEING	90,000	C
3	WRINKLE RESISTANT FINISHES	70,000	C
4	WATER PROOF AND WATER REPELLENT FINISHES	20,000	C
5	PERMANENT CRISPNESS	200	C
	TOTAL	1,000,000	

Table C-21. MAJOR APPLIANCE FINISHING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	REFRIGERATORS	10,000	B
2	ENAMELED PLUMBING FIXTURES	9,000	B
3	RADIOS AND TELEVISIONS	6,000	B
4	DRYERS	5,000	B
5	WASHERS	5,000	B
6	STOVES	5,000	B
7	FREEZERS	4,000	B
8	WATER HEATERS	4,000	B
9	AIR CONDITIONERS	2,000	B
10	FURNACES	2,000	B
11	DISHWASHERS	2,000	B
12	LAWN MOWERS	800	B
13	HUMIDIFIERS	500	B
14	DEHUMIDIFIERS	300	B
15	TRASH COMPACTORS	100	B
16	WATER SOFTENERS	100	B
	TOTAL	60,000	

Table C-22. SMALL APPLIANCE FINISHING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	ELECTRIC FANS	5,000	B
2	LAMPS	2,000	B
3	CARPET CARE APPLIANCES	1,000	B
4	PHONOGRAPHS	400	B
5	ELECTRIC TOOLS	400	B
6	COFFEE POTS	600	B
7	BATHROOM SCALES	600	B
8	SEWING MACHINES	500	B
9	PROJECTORS - MOVIE AND SLIDE	300	B
10	ELECTRIC COOKWARE	300	B
11	MIXERS	300	B
12	BLENDERS	300	B
13	SPACE HEATERS	200	B
14	GARBAGE DISPOSALS	200	B
15	IRONS	200	B
16	CAMERAS	100	B
17	SNOW BLOWERS	100	B
18	TOASTERS	80	C
19	ELECTRIC RAZORS	60	B
20	TAPE RECORDERS	40	C
21	CAN OPENERS AND KNIFE SHARPENERS	30	B
22	HAIR DRYERS	30	C
	TOTAL	10,000	

Table C-23. FARM MACHINERY FINISHING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	BOXES AND RACKS	1,000	B
2	FARM WAGONS	1,000	B
3	FARM ELEVATORS - PORTABLE	600	B
4	HAND SPRAYERS	600	B
5	TRACTORS	500	B
6	POULTRY FEEDERS	400	C
7	COMBINES	400	B
8	STACK SHREDDERS	200	B
9	FORAGE BLOWERS	200	B
10	HOG FEEDING EQUIPMENT	200	B
11	NESTS AND CAGES	100	B
12	TURKEY FEEDERS	100	B
13	BROODERS	90	B
14	MANURE SPREADERS	80	B
15	BALE THROWING ATTACHMENTS	80	B
16	BROADCAST SEEDERS	70	B
17	DAIRY MACHINES	70	B
18	FERTILIZER DISTRIBUTORS	70	B
19	HAND DUSTERS	60	B
20	OTHER SPRAYERS - NON-TRACTOR	50	B
21	FIELD FORAGE HARVESTORS	50	B
22	DRYERS	50	B
23	FOGGERS AND MIST SPRAYERS	40	B
24	POWER SPRAYERS	40	B
25	ROTARY CULTIVATORS	40	B
26	HOG WATERING EQUIPMENT	30	B
27	BLADE TERRACERS	30	B
28	MOWER-CONDITIONERS	30	B
29	INCUBATORS	30	B
30	PEANUT COMBINES	30	B
31	FARM ELEVATORS - STATIONARY	30	B
32	MOWERS	20	B
33	FEED GRINDERS	20	B
34	HAY BALERS	20	B
35	HARROWS	20	B
36	HAY CONDITIONERS	20	B
37	CORN AND COTTON CULTIVATORS	20	B
38	MOLDBOARD PLOWS	20	B
39	FIELD CULTIVATORS	10	B
40	AIR-CARRIED TYPE POWER SPRAYER	10	B
41	WINDROWERS - HAY	10	B
42	HAY STACKING ATTACHMENTS	10	B
43	CORN SHELLERS	10	C
44	CORN PICKERS	8	B
45	CORN PLNTRS, LISTERS, POTATO PLNTRS, TRN	6	B
46	FRONT AND REAR MOUNTED LOADERS	5	B
47	PEANUT DIGGERS	5	B
48	HAY BALE LOADERS	3	B
49	MANURE PUMPS	3	B
50	RAKES	3	B
51	COTTON STRIPPERS	2	B
52	GRAIN DRILLS	2	C
53	FEED MIXERS	2	B
54	POWER DUSTERS	2	B
55	SUBSOILERS - DEEP TILLAGE	2	B
56	MIDDLEBUSTERS AND DISC BEDDERS	2	B
57	BEET HARVESTORS	1	B
58	CHISEL PLOWS	1	B
59	TERRACING AND DITCHING PLOWS	1	B
60	TOBACCO CURERS	1	B
61	POTATO HARVESTORS	1	B
62	LAND LEVELERS	1	A
63	WINDROWERS OR SWATHERS	1	B
64	TURKEY WATERERS	1	C
65	ROD WEEDERS	1	B
66	BEET, BEAN, AND VEGETABLE CULTIVATORS	1	B
67	DISC PLOWS	1	B
68	EGG WASHERS	1	B
69	EGG GRADERS	1	B
	TOTAL	7,000	

Table C-24. INDUSTRIAL MACHINERY FINISHING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	PUMPS	9,000	B
2	SPINNING FRAMES	8,000	B
3	COMPRESSORS	6,000	B
4	TWISTING FRAMES	4,000	B
5	AUTOMOTIVE MAINTENANCE EQUIPMENT	2,000	C
6	ROTARY DRILLING EQUIPMENT - SUBSURFACE	2,000	B
7	SAWING MACHINES - WOOD	1,000	B
8	BLEACHING, DRYING, FINISHING MACHINERY	700	C
9	PACKING, PACKAGING, BOTTLING MACHINERY	700	B
10	REBUILT PULP AND PAPERMILL MACHINERY	600	C
11	GRINDING AND POLISHING MACHINES	600	B
12	CHOPPERS, GRINDERS, CUTTERS, ETC. - FOOD	500	B
13	LATHES, PLANERS, ETC. - WOOD	400	C
14	PRESSES - METAL	400	B
15	WELDING AND CUTTING APPARATUS	300	C
16	INDUSTRIAL TRUCKS	300	B
17	PUNCHING AND SHEARING MACHINES	300	B
18	DRILLING MACHINES	200	B
19	BENDING AND FORMING MACHINES	200	B
20	FLOWING WELL EQUIPMENT	200	C
21	CHEMICAL MANUFACTURING INDUSTRIAL MACH	200	C
22	WOOD PREPARATION EQUIPMENT - PULPMILLS	200	C
23	METAL CLEANING MACHINERY	200	C
24	FRUIT AND VEGETABLE CANNING MACHINERY	200	C
25	MEAT AND POULTRY PROCESSING MACHINERY	200	C
26	KNITTING MACHINES	200	B
27	CEMENT MAKING MACHINERY	200	C
28	LATHES - METAL	100	B
29	CHAIN SAWS	100	B
30	JOINTERS	100	C
31	PAPER AND PAPERBOARD CONVERTING MACHINER	100	B
32	PLASTICS WORKING MACHINERY	100	B
33	HOISTS	100	B
34	ROD LIFTING MACHINERY - OIL	90	C
35	COTTON GINNING MACHINERY	80	C
36	MINE CARS, TRACK	80	B
37	SUGAR PLANT PROCESSING MACHINERY	80	C
38	MILLING MACHINES	70	B
39	TYPESETTING MACHINERY	60	B
40	YARN PREPARING MACHINES	60	B
41	SAWMILL EQUIPMENT	60	C
42	TOBACCO MANUFACTURING MACHINES	50	B
43	SCREENS - MINING	50	B
44	CLAYWORKING MACHINER	50	C
45	OFF-SET LITHOGRAPHIC PRESSES	50	B
46	PAPERMILL MACHINERY	50	B
47	CONSTRUCTION CRANES	40	B
48	SAWING AND CUTOFF MACHINES - METAL	40	B
49	FEEDERS	40	B
50	CLEANING AND OPENING MACHINES	40	B
51	OVERHEAD CRANES	40	B
52	SHOEMAKING MACHINERY	40	C
53	MOTORIZED HAND TRUCKS	40	B
54	CRUSHERS	30	B
55	ICE CREAM FREEZERS	30	C
56	EXCAVATORS	30	B

Table C-24 (Cont.) INDUSTRIAL MACHINERY FINISHING: OPTION 3

57	PLANERS - METAL	30	C
58	HOT ROLLING MILL MACHINES	30	C
59	CONCRETE PRODUCT MACHINERY	20	B
60	SHUTTLE CARS - MINING	20	B
61	FLOUR AND GRAIN MILL MACHINERY	20	C
62	COLD ROLLING MILL MACHINES	20	C
63	FLOTATION MACHINES	20	B
64	GLASS MAKING MACHINERY	20	B
65	GEAR CUTTING MACHINES	10	B
66	CLASSIFIERS	10	B
67	LETTERSET PRINTING PRESSES	10	B
68	BINDERY EQUIPMENT	10	B
69	LOADING, CUTTING, LONGWALL MINING MACH	10	B
70	DRILLS - MINING	10	B
71	FOUNDRY MACHINERY	10	C
72	VENEER AND PLYWOOD EQUIPMENT	10	C
73	PULPMILL MACHINERY	10	B
74	CARDING AND COMBING MACHINES	10	B
75	ELECTRONIC TUBE MANUFACTURING MACHINERY	9	C
76	GRINDING MILLS	8	B
77	MAGNETIC SEPARATORS	7	B
78	HOMOGENIZERS AND PASTEURIZERS	7	B
79	CENTRIFUGAL DRIERS	7	B
80	CONCRETE MIXERS	7	B
81	BAKERY MACHINERY	6	B
82	TAPPING MACHINES	5	B
83	BORING MACHINES	5	B
84	CONTINUOUS MINING MACHINES	5	B
85	BUTTER AND CHEESE PROCESSING MACHINERY	4	B
86	WET CYCLONES - MINING	4	B
87	SCRUBBERS - MINING	2	B
88	GRAVURE PRINTING PRESSES	2	B
89	THERMAL DRIERS - MINING	2	B
90	CONCENTRATING TABLES	1	B
91	FLEXOGRAPHIC PRINTING PRESSES	1	B
92	BROACHING MACHINES	1	B
93	ROTARY DRILLING EQUIPMENT - SURFACE	1	B
94	WASHING AND STERILIZING EQUIPMENT	1	C
95	SHAPERS - METAL	1	B
	TOTAL	40,000	

Table C-25. COMMERCIAL MACHINERY FINISHING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	VENDING MACHINES	5,000	B
2	TYPEWRITERS	2,000	B
3	MAILING AND PARCEL POST SCALES	800	B
4	DUPLICATING MACHINES	500	B
5	INDUSTRIAL WATER SOFTENERS	400	B
6	GASOLINE PUMPS	200	B
7	MAILING MACHINES	200	B
8	ADDING MACHINES	100	B
9	TIME RECORDERS	100	B
10	MOTOR TRUCK SCALES	100	B
11	FORMS HANDLING EQUIPMENT	100	B
12	COMMERCIAL DISHWASHERS	90	B
13	CHECK HANDLING MACHINES	80	B
14	CASH REGISTERS	60	C
15	DICTATING MACHINES	50	B
16	ACCOUNTING MACHINES	40	C
17	COMMERCIAL FLOOR WAXERS	30	B
18	RETAIL AND COMMERCIAL SCALES	20	B
19	COMMERCIAL CARPET SWEEPERS	9	B
20	ELECTRONIC CALCULATORS	4	B
	TOTAL	9,000	

Table C-26. WOOD FURNITURE FINISHING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	BEDROOM FURNITURE	9,000	B
2	TABLES	8,000	B
3	CABINETS	7,000	B
4	CHAIRS	6,000	B
5	DESKS	1,000	B
6	BOOKCASES	400	B
	TOTAL	30,000	

Table C-27. SHEET, STRIP, AND COIL COATING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	METAL CANS - EXCLUDING BEVERAGE CANS	1,000,000	B
2	BEVERAGE CANS	700,000	B
3	DUCTWORK	200,000	C
4	WOOD PANELING	200,000	C
5	CANOPIES AND AWNINGS	50,000	C
6	SCREENING	50,000	B
7	FENCING	30,000	B
8	BEER AND SOFT DRINK BOTTLE CAPS	10,000	B
9	GUTTERS	10,000	B
10	METAL DOORS - EXCLUDING GARAGE DOORS	10,000	B
11	ALUMINUM SIDING AND ROOFING	6,000	B
12	GARAGE DOORS	4,000	B
13	DOOR AND WINDOW FRAMES	3,000	B
14	RAILINGS, FIRE ESCAPES, STAIRCASES	1,000	B
15	SHELVING	200	C
16	WIRE PRODUCTS	100	C
17	STEEL SHIPPING BARRELS	90	B
	TOTAL	3,000,000	

Table C-28. METAL FURNITURE FINISHING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	FILING CABINETS	10,000	B
2	DESKS	7,000	B
3	TABLES	5,000	B
4	CHAIRS	5,000	B
5	COAT RACKS	2,000	C
6	SAFES AND VAULTS	1,000	B
7	CABINETS	1,000	C
8	WASTE CANS	400	C
9	BOOK CASES	80	B
	TOTAL	30,000	

Table C-29. PAPER AND PAPERBOARD COATING: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	COATED PAPER - EXCLUDING WAXED	10,000,000	B
2	PRINTING PAPER	6,000,000	B
3	PAPER BOXES	2,000,000	B
4	MILK CARTON BOARD	2,000,000	B
5	OILED AND WAXED PAPER	1,000,000	B
6	FOLDING CARTONS	700,000	B
7	PAPER BAGS	900,000	B
8	KRAFT PAPER	500,000	B
9	PAPER CANS, TUBES, DRUMS	200,000	B
	TOTAL	20,000,000	

Table C-30. FABRIC TREATMENT: OPTION 3

RANK	SOURCE TYPE	IMPACT FACTOR	CL
1	SIZING	1,000,000	C
2	DYEING	900,000	C
3	WRINKLE RESISTANT FINISHES	70,000	C
4	WATER PROOF AND WATER REPELLENT FINISHES	20,000	C
5	PERMANENT CRISPNESS	1,000	C
	TOTAL	2,000,000	

Table C-31. MAJOR APPLIANCE FINISHING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	REFRIGERATORS	7,000,000,000	B
2	ENAMELED PLUMBING FIXTURES	3,000,000,000	B
3	DRYERS	3,000,000,000	B
4	WASHERS	3,000,000,000	B
5	STOVES	2,000,000,000	B
6	RADIOS AND TELEVISIONS	2,000,000,000	B
7	FREEZERS	2,000,000,000	B
8	WATER HEATERS	1,000,000,000	B
9	AIR CONDITIONERS	1,000,000,000	B
10	FURNACES	1,000,000,000	B
11	DISHWASHERS	1,000,000,000	B
12	LAWN MOWERS	400,000,000	B
13	HUMIDIFIERS	200,000,000	B
14	DEHUMIDIFIERS	80,000,000	B
15	WATER SOFTENERS	40,000,000	B
16	TRASH COMPACTORS	30,000,000	B
	TOTAL	30,000,000,000	

Table C-32. SMALL APPLIANCE FINISHING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	ELECTRIC FANS	1,000,000,000	B
2	LAMPS	400,000,000	B
3	CARPET CARE APPLIANCES	300,000,000	B
4	PHONOGRAPHS	200,000,000	B
5	BATHROOM SCALES	100,000,000	B
6	MIXERS	100,000,000	B
7	ELECTRIC TOOLS	100,000,000	B
8	SEWING MACHINES	100,000,000	B
9	COFFEE POTS	90,000,000	B
10	GARBAGE DISPOSALS	80,000,000	B
11	ELECTRIC COOKWARE	80,000,000	B
12	SPACE HEATERS	70,000,000	B
13	PROJECTORS - MOVIE AND SLIDE	70,000,000	B
14	IRONS	60,000,000	B
15	BLENDERS	50,000,000	B
16	SNOW BLOWERS	50,000,000	B
17	CAMERAS	30,000,000	B
18	TOASTERS	20,000,000	C
19	ELECTRIC RAZORS	10,000,000	B
20	HAIR DRYERS	10,000,000	C
21	TAPE RECORDERS	8,000,000	C
22	CAN OPENERS AND KNIFE SHARPENERS	5,000,000	B
	TOTAL	3,000,000,000	

Table C-33. FARM MACHINERY FINISHING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	TRACTORS	400,000,000	B
2	POULTRY FEEDERS	200,000,000	C
3	FARM WAGONS	200,000,000	B
4	HAND SPRAYERS	200,000,000	B
5	BOXES AND RACKS	100,000,000	B
6	FARM ELEVATORS - PORTABLE	100,000,000	B
7	HOG FEEDING EQUIPMENT	60,000,000	B
8	COMBINES	60,000,000	B
9	NESTS AND CAGES	40,000,000	B
10	TURKEY FEEDERS	40,000,000	B
11	STACK SHREDDERS	30,000,000	B
12	BROODERS	30,000,000	B
13	FORAGE BLOWERS	20,000,000	B
14	DAIRY MACHINES	20,000,000	B
15	HOG WATERING EQUIPMENT	20,000,000	B
16	BALE THROWING ATTACHMENTS	20,000,000	B
17	MANURE SPREADERS	20,000,000	B
18	BROADCAST SEEDERS	20,000,000	B
19	FERTILIZER DISTRIBUTORS	10,000,000	B
20	FIELD FORAGE HARVESTORS	9,000,000	B
21	ROTARY CULTIVATORS	8,000,000	B
22	BLADE TERRACERS	8,000,000	B
23	OTHER SPRAYERS - NON-TRACTOR	8,000,000	B
24	HAND DUSTERS	8,000,000	B
25	PEANUT COMBINES	7,900,000	B
26	DRYERS	7,000,000	B
27	MOWER-CONDITIONERS	7,000,000	B
28	INCUBATORS	6,000,000	B
29	FOGGERS AND MIST SPRAYERS	6,000,000	B
30	POWER SPRAYERS	6,000,000	B
31	FARM ELEVATORS - STATIONARY	6,000,000	B
32	MOWERS	5,000,000	B
33	HARROWS	5,000,000	B
34	HAY BALERS	4,000,000	B
35	CORN AND COTTON CULTIVATORS	4,000,000	B
36	HAY CONDITIONERS	4,000,000	B
37	CORN PLNTRS, LISTERS, POTATO PLNTRS, CRN	3,000,000	B
38	FEED GRINDERS	3,000,000	B
39	FIELD CULTIVATORS	3,000,000	B
40	MOLDBOARD PLOWS	3,000,000	B
41	WINDROWERS - HAY	3,000,000	B
42	HAY STACKING ATTACHMENTS	2,000,000	B
43	AIR-CARRIED TYPE POWER SPRAYER	2,000,000	B
44	CORN PICKERS	2,000,000	B
45	CORN SHELLERS	2,000,000	C
46	PEANUT DIGGERS	1,000,000	B
47	FRONT AND REAR MOUNTED LOADERS	1,000,000	B
48	HAY BALE LOADERS	700,000	B
49	TOBACCO CURERS	500,000	B
50	GRAIN DRILLS	500,000	C
51	RAKES	500,000	B
52	COTTON STRIPPERS	500,000	B
53	LAND LEVELERS	400,000	B
54	SUBSOILERS - DEEP TILLAGE	400,000	B
55	CHISEL PLOWS	300,000	B
56	TERRACING AND DITCHING PLOWS	300,000	B
57	WINDROWERS OR SWATHERS	300,000	B
58	MANURE PUMPS	300,000	B
59	BEET HARVESTORS	300,000	B
60	POTATO HARVESTORS	300,000	B
61	TURKEY WATERERS	300,000	C
62	POWER DUSTERS	300,000	B
63	MIDDLEBUSTERS AND DISC BEDDERS	200,000	B
64	FEED MIXERS	200,000	B
65	ROD WEEDERS	200,000	B
66	DISC PLOWS	60,000	B
67	BEET, BEAN, AND VEGETABLE CULTIVATORS	60,000	B
68	EGG WASHERS	30,000	B
69	EGG GRADERS	10,000	B
	TOTAL	2,000,000,000	

Table C-34. INDUSTRIAL MACHINERY FINISHING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	PUMPS	2,000,000,000	B
2	SPINNING FRAMES	2,000,000,000	B
3	TWISTING FRAMES	1,000,000,000	B
4	COMPRESSORS	600,000,000	B
5	ROTARY DRILLING EQUIPMENT - SUBSURFACE	500,000,000	B
6	AUTOMOTIVE MAINTENANCE EQUIPMENT	300,000,000	C
7	SAWING MACHINES - WOOD	200,000,000	B
8	MEAT AND POULTRY PROCESSING MACHINERY	100,000,000	C
9	CHAIN SAWS	70,000,000	B
10	FLOWING WELL EQUIPMENT	70,000,000	C
11	PACKING, PACKAGING, BOTTLING MACHINERY	70,000,000	B
12	CHOPPERS, GRINDERS, CUTTERS, ETC. - FOOD	70,000,000	B
13	LATHES, PLANERS, ETC. - WOOD	70,000,000	C
14	GRINDING AND POLISHING MACHINES	60,000,000	B
15	PRESSES - METAL	50,000,000	B
16	WOOD PREPARATION EQUIPMENT - PULPMILLS	50,000,000	C
17	INDUSTRIAL TRUCKS	50,000,000	B
18	BLEACHING, DYEING, FINISHING MACHINERY	40,000,000	C
19	REBUILT PULP AND PAPERMILL MACHINERY	30,000,000	C
20	PUNCHING AND SHEARING MACHINES	30,000,000	B
21	ROD LIFTING MACHINERY - OIL	30,000,000	C
22	WELDING AND CUTTING APPARATUS	20,000,000	C
23	BENDING AND FORMING MACHINES	20,000,000	B
24	DRILLING MACHINES	20,000,000	B
25	FRUIT AND VEGETABLE CANNING MACHINERY	20,000,000	C
26	JOINTERS	20,000,000	C
27	METAL CLEANING MACHINERY	20,000,000	C
28	CHEMICAL MANUFACTURING INDUSTRIAL MACH	20,000,000	C
29	MILLING MACHINES	20,000,000	B
30	CONSTRUCTION CRANES	20,000,000	B
31	CEMENT MAKING MACHINERY	20,000,000	C
32	SAWMILL EQUIPMENT	20,000,000	C
33	HOISTS	10,000,000	B
34	COTTON GINNING MACHINERY	10,000,000	C
35	KNITTING MACHINES	10,000,000	B
36	TYPESETTING MACHINERY	10,000,000	B
37	OVERHEAD CRANES	10,000,000	B
38	LATHES - METAL	10,000,000	B
39	MINE CARS, TRACK	10,000,000	B
40	PLASTICS WORKING MACHINERY	8,000,000	B
41	PAPER AND PAPERBOARD CONVERTING MACHINER	8,000,000	B
42	SUGAR PLANT PROCESSING MACHINERY	8,000,000	C
43	MOTORIZED HAND TRUCKS	6,000,000	B
44	YARN PREPARING MACHINES	6,000,000	B
45	SCREENS - MINING	6,000,000	B
46	CLEANING AND OPENING MACHINES	5,000,000	B
47	CRUSHERS	5,000,000	B
48	PAPERMILL MACHINERY	5,000,000	B
49	EXCAVATORS	5,000,000	B
50	SAWING AND CUTOFF MACHINES - METAL	4,000,000	B
51	TOBACCO MANUFACTURING MACHINES	4,000,000	B
52	FEEDERS	4,000,000	B
53	CLAYWORKING MACHINER	4,000,000	C
54	FLOTATION MACHINES	4,000,000	B
55	OFF-SET LITHOGRAPHIC PRESSES	3,000,000	B
56	SHOEMAKING MACHINERY	3,000,000	C

Table C-34 (Cont.) INDUSTRIAL MACHINERY FINISHING: OPTION 4

57	ICE CREAM FREEZERS	3,000,000	C
58	SHUTTLE CARS - MINING	3,000,000	B
59	VENEER AND PLYWOOD EQUIPMENT	2,000,000	C
60	CONCRETE PRODUCT MACHINERY	2,000,000	B
61	HOT ROLLING MILL MACHINES	2,000,000	C
62	LOADING, CUTTING, LONGWALL MINING MACH	2,000,000	B
63	PLANERS - METAL	2,000,000	C
64	CLASSIFIERS	2,000,000	B
65	FLOUR AND GRAIN MILL MACHINERY	2,000,000	C
66	GLASS MAKING MACHINERY	2,000,000	B
67	COLD ROLLING MILL MACHINES	2,000,000	C
68	CARDING AND COMBING MACHINES	1,000,000	B
69	FOUNDRY MACHINERY	1,000,000	C
70	GEAR CUTTING MACHINES	1,000,000	B
71	DRILLS - MINING	1,000,000	B
72	PULPMILL MACHINERY	1,000,000	B
73	CONCRETE MIXERS	1,000,000	B
74	BINDERY EQUIPMENT	900,000	B
75	LETTERSET PRINTING PRESSES	900,000	B
76	MAGNETIC SEPARATORS	800,000	B
77	CONTINUOUS MINING MACHINES	700,000	B
78	GRINDING MILLS	700,000	B
79	HOMOGENIZERS AND PASTEURIZERS	600,000	B
80	BUTTER AND CHEESE PROCESSING MACHINERY	600,000	B
81	BAKERY MACHINERY	600,000	B
82	WET CYCLONES - MINING	500,000	B
83	CENTRIFUGAL DRIERS	500,000	B
84	TAPPING MACHINES	500,000	C
85	BORING MACHINES	400,000	B
86	ELECTRONIC TUBE MANUFACTURING MACHINERY	400,000	C
87	SCRUBBERS - MINING	300,000	B
88	CONCENTRATING TABLES	300,000	B
89	ROTARY DRILLING EQUIPMENT - SURFACE	200,000	B
90	THERMAL DRIERS - MINING	200,000	B
91	GRAVURE PRINTING PRESSES	100,000	B
92	FLEXOGRAPHIC PRINTING PRESSES	100,000	B
93	BROACHING MACHINES	90,000	B
94	WASHING AND STERILIZING EQUIPMENT	60,000	C
95	SHAPERS - METAL	20,000	B
	TOTAL	8,000,000,000	

Table C-35. COMMERCIAL MACHINERY FINISHING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	VENDING MACHINES	600,000,000	B
2	TYPEWRITERS	100,000,000	B
3	DUPLICATING MACHINES	90,000,000	B
4	MAILING AND PARCEL POST SCALES	50,000,000	B
5	GASOLINE PUMPS	30,000,000	B
6	INDUSTRIAL WATER SOFTENERS	30,000,000	B
7	MAILING MACHINES	20,000,000	B
8	ADDING MACHINES	20,000,000	B
9	CASH REGISTERS	20,000,000	C
10	COMMERCIAL DISHWASHERS	20,000,000	B
11	CHECK HANDLING MACHINES	10,000,000	B
12	MOTOR TRUCK SCALES	10,000,000	B
13	FORMS HANDLING EQUIPMENT	9,000,000	B
14	TIME RECORDERS	7,000,000	B
15	DICTATING MACHINES	7,000,000	B
16	ACCOUNTING MACHINES	3,000,000	C
17	COMMERCIAL FLOOR WAXERS	3,000,000	B
18	RETAIL AND COMMERCIAL SCALES	2,000,000	B
19	COMMERCIAL CARPET SWEEPERS	800,000	B
20	ELECTRONIC CALCULATORS	800,000	B
	TOTAL	1,000,000,000	

Table C-36. WOOD FURNITURE FINISHING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	BEDROOM FURNITURE	4,000,000,000	B
2	TABLES	2,000,000,000	B
3	CABINETS	2,000,000,000	B
4	CHAIRS	700,000,000	B
5	DESKS	300,000,000	B
6	BOOKCASES	100,000,000	B
	TOTAL	9,000,000,000	

Table C-37. SHEET, STRIP, AND COIL COATING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	METAL CANS - EXCLUDING BEVERAGE CANS	200,000,000,000	B
2	BEVERAGE CANS	200,000,000,000	B
3	DUCTWORK	40,000,000,000	C
4	WOOD PANELING	10,000,000,000	C
5	CANOPIES AND AWNINGS	10,000,000,000	C
6	SCREENING	5,000,000,000	B
7	FENCING	4,000,000,000	B
8	METAL DOORS - EXCLUDING GARAGE DOORS	2,000,000,000	B
9	GUTTERS	2,000,000,000	B
10	ALUMINUM SIDING AND ROOFING	2,000,000,000	B
11	BEER AND SOFT DRINK BOTTLE CAPS	1,000,000,000	B
12	GARAGE DOORS	600,000,000	B
13	DOOR AND WINDOW FRAMES	600,000,000	B
14	RAILINGS, FIRE ESCAPES, STAIRCASES	300,000,000	B
15	SHELVING	40,000,000	C
16	STEEL SHIPPING BARRELS	20,000,000	B
17	WIRE PRODUCTS	20,000,000	C
	TOTAL	500,000,000,000	

Table C-38. METAL FURNITURE FINISHING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	FILING CABINETS	3,000,000,000	B
2	DESKS	2,000,000,000	B
3	TABLES	1,000,000,000	B
4	CHAIRS	1,000,000,000	B
5	COAT RACKS	600,000,000	C
6	SAFES AND VAULTS	400,000,000	B
7	CABINETS	300,000,000	C
8	WASTE CANS	100,000,000	C
9	BOOK CASES	30,000,000	B
	TOTAL	8,000,000,000	

Table C-39. PAPER AND PAPERBOARD COATING: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	PAPER BAGS	200,000,000,000	B
2	KRAFT PAPER	70,000,000,000	B
3	COATED PAPER - EXCLUDING WAXED	70,000,000,000	B
4	PRINTING PAPER	50,000,000,000	B
5	OILED AND WAXED PAPER	40,000,000,000	B
6	MILK CARTON BOARD	20,000,000,000	B
7	PAPER BOXES	20,000,000,000	B
8	FOLDING CARTONS	5,000,000,000	B
9	PAPER CANS, TUBES, DRUMS	2,000,000,000	B
	TOTAL	500,000,000,000	

Table C-40. FABRIC TREATMENT: OPTION 4

RANK	SOURCE TYPE	EMISSION RATE	CL
1	DYEING	200,000,000,000	C
2	SIZING	10,000,000,000	C
3	WRINKLE RESISTANT FINISHES	800,000,000	C
4	PERMANENT CRISPNESS	200,000,000	C
5	WATER PROOF AND WATER REPELLENT FINISHES	9,000,000	C
	TOTAL	200,000,000,000	

APPENDIX D

PRIORITIZATION COMPUTER PROGRAMS

```
C     PROGRAM SCE
C     THIS PROGRAM CALCULATES IMPACT FACTORS
C     FOR SOLVENT EVAPORATION FROM SURFACE COATINGS
C
C     THESE CALCULATIONS ARE "LOCATION SENSITIVE"
C
      DIMENSION IDESC(20),IDUM1(18),ICODE(51),NPLTS(51),
     1EF(25),AEF(25),IARR(30),TLV(25),IDUM (4),ISOLV(25),ME(12,25)
      EQUIVALENCE(IDESC(1),IARR(1)),(IDUM(1),IOPTN)
      DATA TLV/2.79,0.375,0.5,0.59,0.71,0.12,0.67,0.,0.,0.,0.012,
     10.0026,0.41,0.019,0.00014,0.59,0.006,0.001,0.42,0.012,0.56,
     20.4,0.56,0.019,0.003/
      DATA ME/'AL','IP','HA','TI','C ','HY','DR','OC','AR','BO','NS','
     1','AR','OM','AT','IC',' H','YD','RO','CA','RB','ON','S ','  ',
     2'SA','TU','RA','TE','D ','AL','CO','HO','LS','  ','  ','  ',
     3'KE','TO','NE','S ',8*'  ','SA','TU','RA','TE','D ','ES','TE','RS'
     4,4*'  ','SA','TU','RA','TE','D ','ET','HE','RS',4*'  ','CH','LO',
     5'RI','NA','TE','D ','HY','DR','OC','AR','BO','NS',36*'  ','AL',
     6'KY','D ',9*'  ','VI','NY','L ',9*'  ','AC','RY','LI','C ',8*'  ',
     7'EP','OX','Y ',9*'  ','UR','ET','HA','NE',8*'  ','CE','LL','UL',
     8'OS','IC',7*'  ','AM','IN','O ',9*'  ','RO','SI','N ','ES','TE',
     9'R ',6*'  ','ST','YR','EN','E ',8*'  ','PH','EN','OL','IC',8*'  ',
     1'HY','DR','OC','AR','BO','N ',6*'  ','ET','HE','NY','LO','XA',
     1'ZO','LI','NE',4*'  ','PO','LY','(1','-B','UT','EN','E)',5*'  ',
     2'ME','LA','MI','NE',8*'  ','FO','RM','AL','DE','HY','DE',6*'  '/
      DEFINE FILE ISTAT(50,35,U,NEXT1)
      PI=3.1415927
      E=2.7182818
      LIN=1
      LLN=4
      LOUT=5
      ISTAT=2
      IMPCT=3
      VEL=4.47
      YPS=3.1688088E-08
      SPY=3.1536E07
      PCTLV=0.0672
      AHE=50.
      SKSM=0.3860989
C
C     THE FOLLOWING "READ STATEMENT" SPECIFIES I/O OPTIONS
C         IOUTPT=1 FOR INPUT DATA PRINTOUT
C         IOUTPT=0 FOR SUPPRESSION OF INPUT DATA PRINTOUT
C         IOPTN=1 USE SPECIFIC TLV FOR CALCULATION OF IMPACT FACTOR
C         IOPTN=2 USE PHOTOCHEMICAL TLV FOR ALL POLLUTANTS
C         IOPTN=3 USE PHOTOCHEMICAL TLV OR ACTUAL TLV,
C           WHICHEVER IS SMALLER
C         IOPTN=4 DO EMISSION RATE CALCULATIONS ONLY
C         IRPT=0 DO CALCULATIONS
C         IRPT=1 GENERATE REPORT FROM DISK FILE ONLY
C
      READ(LLN,501) IOUTPT,IOPTN,IRPT
      IF(IRPT.EQ.1) GO TO 90
C
C     THE FOLLOWING "READ STATEMENTS" READ INPUT DATA
C
    1 READ(LIN,502) IDESC,TPROD,FRQ,APS,IQUAL,ITYPE,ICAT,IDENT
      IF(IDESC(1).EQ.X'A4A4') GO TO 90
      DO 10 I=1,4
      IF(I.EQ.1) J=1
      IF(I.EQ.2) J=15
      IF(I.EQ.3) J=29
      IF(I.EQ.4) J=43
      K=J+13
      READ(LIN,503) (ICODE(L),NPLTS(L),L=J,K)
      DO 11 M=J,K
   11 IF(ICODE(M).EQ.99) GO TO 9
   10 CONTINUE
    9 LAST=M-1
C
C     TO CALCULATE UNIT PLANT PRODUCTION
C
      DO 55 I=1,25
   55 EF(I)=0.0
      ITOT=0
      DO 3 I=1,LAST
    3 ITOT=ITOT+NPLTS(I)
      UPPROD=TPROD/FLOAT(ITOT)
      READ(LIN,504) ISOLV,(EF(I),I=1,9)
      ITOT=0
      DO 6 I=1,25
    8 ITOT=ITOT+ISOLV(I)
      IF(ITOT.LE.9) GO TO 30
      IF(ITOT.GT.9.AND.ITOT.LE.18) J=1
      IF(ITOT.GT.18.AND.ITOT.LE.27) J=2
      DO 7 I=1,J
      K=I*9+1
      L=K+8
      READ(LIN,505) (EF(M),M=K,L)
    7 CONTINUE
C
C     THIS SECTION TESTS FOR THE NUMBER OF POLLUTANTS
C     EMITTED BEING EQUAL TO TOTAL NUMBER OF 1'S IN
C     CODE (TOTAL ISOLV = TOTAL NUMBER OF EF'S)
C
   30 DO 6 I=1,25
    6 IF(EF(I).EQ.0.0) GO TO 31
   31 NEF=I-1
      IF(NEF.NE.ITOT) GO TO 99
C
C     NOW TO PUT EF IN APPROPRIATE SLOT IN AEF VECTOR
C
      J=1
      DO 5 I=1,25
      IF(ISOLV(I).EQ.0) GO TO 4
      AEF(I)=EF(J)
      J=J+1
      GO TO 5
    4 AEF(I)=0.0
    5 CONTINUE
C
C     INPUT DATA PRINTOUT SECTION
C
      IF(IOUTPT.EQ.0) GO TO 25
      WRITE(LOUT,601) IDESC,IDENT
      WRITE(LOUT,602) IOPTN,IQUAL,ITYPE,ICAT
      WRITE(LOUT,603) TPROD
      WRITE(LOUT,604) FRQ
      WRITE(LOUT,605) APS
      IF(LAST.LE.25) KOUNT=25
      IF(LAST.GT.25) KOUNT=LAST
      WRITE(LOUT.620)
   40 DO 45 I=1.KOUNT
      IF(KOUNT-25) 46.46.47
   47 IF(I.GT.25.OR.AEF(I).EQ.0.0) GO TO 48
      WRITE(LOUT.606) ICODE(I).NPLTS(I).(ME(K.I).K=1.12).AEF(I)
      GO TO 45
   48 WRITE(LOUT.607) ICODE(I).NPLTS(I)
      GO TO 45
   46 IF(AEF(I).EQ.0.0.AND.LAST.LT.I) GO TO 45
      IF(AEF(I).NE.0.0.AND.LAST.GE.I) GO TO 44
      IF(AEF(I).NE.0.0.AND.LAST.LT.I) GO TO 43
      IF(AEF(I).EQ.0.0.AND.LAST,GE,I) GO TO 41
   44 WRITE(LOUT.606) ICODE(I).NPLTS(I).(ME(K.I).K=1.12).AEF(I)
      GO TO 45
   43 WRITE(LOUT.608) (ME(K.I).K=1.12).AEF(I)
      GO TO 45
   41 WRITE(LOUT.607) ICODE(I).NPLTS(I)
   45 CONTINUE
C
C     CALCULATE IMPACT FACTOR
C
   25 FIMP=0.0
      DO 12 I=1.50
      IF(ICODE(I).EQ.99) GO TO 21
      READ(ISTAT'ICODE(I)) IDUM1.POPD
      SUM=0.0
      DO 13 J=1.25
      IF(J.EQ.8.OR.J.EQ.9.OR.J.EQ.10) GO TO 13
      SPROD=UPPROD*FLOAT(NPLTS(I))
      Q=AEF(J)*SPROD*YPS/FRQ
      IF(IOPTN.EQ.4) GO TO 16
      HSQ=(AHE*0.3048)**2
      CHI=2,*Q/(PI*HSQ*E*VEL)
      IF(IOPTN.EQ.3) GO TO 15
      IF(IOPTN.EQ.2) ATLV=PCTLV
      IF(IOPTN.EQ.1) ATLV=TLV(J)
      GO TO 17
   15 IF(PCTLV.LT.TLV(J)) ATLV=PCTLV
      IF(PCTLV,GE.TLV(J)) ATLV=TLV(J)
      GO TO 17
   16 SUM=SUM+Q*SPY*FRQ
      GO TO 13
   17 F=2,38095E-03*ATLV
      TERM=CHI/F*CHI/F
      SUM=SUM+TERM
   13 CONTINUE
      IF(IOPTN.EQ.4) GO TO 18
      FIMP=FIMP+SQRT(SUM)*POPD*SKSM
      GO TO 12
   18 FIMP=FIMP+SUM
   12 CONTINUE
   21 CALL FILWRT(IMPCT.300.39.IARR,FIMP.IDUM.ITYPE.ICAT.IQUAL)
      GO TO 1
   99 WRITE(LOUT.610) IDESC
      GO TO 1
   90 CALL SCERPT(IMPCT)
      CALL EXIT
  501 FORMAT(I1.1X.I1.1X.I1)
  502 FORMAT(20A2.F10.7.F4.3.F10.7.T70.A1.I1.T76.I2.I3)
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503 FORMAT(14(I2,I3))
504 FORMAT(25I1,9F5.2)
505 FORMAT(T26,9F5.2)
601 FORMAT(1H1,T21,20A2,T85,I4/)
602 FORMAT(1H0,T21,'OPTION  ',I1,T40,'DATA QUALITY  ',A1,
   1T60,'TYPE OF CALC  ',I1,T80,'CATEGORY  ',I2/)
603 FORMAT(1H0,T21,'TOTAL PRODUCTION',T41,E15.7)
604 FORMAT(1H0,T21,'FREQ OF OPERATION',T41,F6.4)
605 FORMAT(1H0,T21,'AVG PLANT SIZE',T41,E15.7/)
610 FORMAT(1H0,T21,'NO OF SOLV, & RESINS AND EMISSION FACTOR NOT = FOR
   1 ',20A2)
620 FORMAT(1H0,T21,'STATE CODE   NO OF PLANTS',T56,'MATERIAL EMITTED',
   1T86,'EMISSION FACTOR'/)
606 FORMAT(1H ,T25,I2,T37,I3,T56,12A2,T86,E15.7)
607 FORMAT(1H ,T25,I2,T37,I3)
608 FORMAT(1H ,T56,12A2,T86,E15.7)
    END
```

```
      SUBROUTINE SCERPT(LU)
C
C     THIS SUBROUTINE GENERATES IMPACT FOACOR LIST
C     FOR SURFACE COATING EVAPORATION PROGRAM
C
      DIMENSION AFIMP(6),IDESC(30),ISCC(4)
      DATA ADUM/'    '/
      DEFINE FILE LU(600,39,U,NEXT)
      LIN=1
      LOUT=5
      READ(LU'1) IDESC,FIMP,ISCC,ISTART
      LAST=ISTART-1
      READ(LU'2) IDESC,FIMP,ISCC,ISTART
      IOPTN=ISCC(1)
      DO 99 IS=1,11
      IF(IS.EQ.1) WRITE(LOUT,511) IOPTN
      IF(IS.EQ.2) WRITE(LOUT,512) IOPTN
      IF(IS.EQ.3) WRITE(LOUT,513) IOPTN
      IF(IS.EQ.4) WRITE(LOUT,514) IOPTN
      IF(IS.EQ.5) WRITE(LOUT,515) IOPTN
      IF(IS.EQ.6) WRITE(LOUT,516) IOPTN
      IF(IS.EQ.7) WRITE(LOUT,517) IOPTN
      IF(IS.EQ.8) WRITE(LOUT,518) IOPTN
      IF(IS.EQ.9) WRITE(LOUT,519) IOPTN
      IF(IS.EQ.10) WRITE(LOUT,520) IOPTN
      IF(IS.EQ.11) WRITE(LOUT,521) IOPTN
      IF(IOPTN.EQ.4.AND.IS.NE.11) WRITE(LOUT,524)
      IF(IOPTN.NE.4.AND.IS.NE.11) WRITE(LOUT,522)
      IF(IOPTN.EQ.4.AND.IS.EQ.11) WRITE(LOUT,525)
      IF(IOPTN.NE.4.AND.IS.EQ.11) WRITE(LOUT,526)
      IF(IS.NE.11) WRITE(LOUT,523)
      IF(IS.EQ.11) WRITE(LOUT,527)
      TOTAL=0.0
      K=0
      DO 9 IND=2,LAST
      READ(LU'IND) IDESC,FIMP,ISCC,ITYPE,ICAT,IQUAL
      IF(IS.EQ.11) GO TO 6
      IF(ICAT.NE.IS) GO TO 9
    6 IF(FIMP.EQ.0.0) GO TO 80
      TOTAL=TOTAL+FIMP
      CALL ROUND(1,FIMP,I,IC)
      CALL REFMT1(I,IC,AFIMP,ISTMT)
      GO TO 70
   80 DO 7 J=1,6
    7 AFIMP(J)=ADUM
      ISTMT=7
   70 K=K+1
      IF(IS.EQ.11) GO TO (71,72,73,74,75,76,77), ISTMT
      GO TO (91,92,93,94,95,96,97), ISTMT
   91 WRITE(LOUT,501) K,(IDESC(JK),JK=1,20), AFIMP,IQUAL
      GO TO 9
   92 WRITE(LOUT,502) K,(IDESC(JK),JK=1,20), AFIMP,IQUAL
      GO TO 9
   93 WRITE(LOUT,503) K,(IDESC(JK),JK=1,20), AFIMP,IQUAL
      GO TO 9
   94 WRITE(LOUT,504) K,(IDESC(JK),JK=1,20), AFIMP,IQUAL
      GO TO 9
   95 WRITE(LOUT,505) K,(IDESC(JK),JK=1,20), AFIMP,IQUAL
      GO TO 9
   96 WRITE(LOUT,506) K,(IDESC(JK),JK=1,20), AFIMP,IQUAL
```

```
      GO TO 9
   97 WRITE(LOUT.507) K.(IDESC(JK).JK=1.20). AFIMP.IQUAL
      GO TO 9
   71 WRITE(LOUT.501) K.(IDESC(JK).JK=1.20). AFIMP.IQUAL.ICAT
      GO TO 9
   72 WRITE(LOUT.502) K.(IDESC(JK).JK=1.20). AFIMP.IQUAL.ICAT
      GO TO 9
   73 WRITE(LOUT.503) K.(IDESC(JK).JK=1.20). AFIMP.IQUAL.ICAT
      GO TO 9
   74 WRITE(LOUT.504) K.(IDESC(JK).JK=1.20). AFIMP.IQUAL.ICAT
      GO TO 9
   75 WRITE(LOUT.505) K.(IDESC(JK).JK=1.20). AFIMP.IQUAL.ICAT
      GO TO 9
   76 WRITE(LOUT.506) K.(IDESC(JK).JK=1.20). AFIMP.IQUAL.ICAT
      GO TO 9
   77 WRITE(LOUT.507) K.(IDESC(JK).JK=1.20). AFIMP.IQUAL.ICAT
    9 CONTINUE
      IF(IS.EQ.11) GO TO 99
      IF(TOTAL.EQ.0.0) GO TO 99
      CALL ROUND(1.TOTAL.I.IC)
      CALL REFMT1(I.IC.AFIMP.ISTMT)
      GO TO (81.82.83.84.85.86). ISTMT
   81 WRITE(LOUT.531) AFIMP
      GO TO 99
   82 WRITE(LOUT.532) AFIMP
      GO TO 99
   83 WRITE(LOUT.533) AFIMP
      GO TO 99
   34 WRITE(LOUT.534) AFIMP
      GO TO 99
   85 WRITE(LOUT.535) AFIMP
      GO TO 99
   86 WRITE(LOUT.536) AFIMP
   99 CONTINUE
      RETURN
  501 FORMAT(1H .T20.I3.5X.20A2.14X.A3.' '.A3.' '.A3.' '.A3.' '.A3.' '.
     1A3.3X.A1.3X.I2)
  502 FORMAT(1H .T20.I3.5X.20A2.14X.A3.' '.A3.' '.A3.' '.A3.' '.A3.','.
     1A3.3X.A1.3X.I2)
  503 FORMAT(1H .T20.I3.5X.20A2.14X.A3.' '.A3.' '.A3.' '.A3.','.A3.','.
     1A3.3X.A1.3X.I2)
  504 FORMAT(1H .T20.I3.5X.20A2.14X.A3.' '.A3.' '.A3.','.A3.','.A3.','.
     1A3.3X.A1.3X.I2)
  505 FORMAT(1H .T20.I3.5X.20A2.14X.A3.' '.A3.','.A3.','.A3.','.A3.','.
     1A3.3X.A1.3X.I2)
  506 FORMAT(1H .T20.I3.5X.20A2.14X.A3.','.A3.','.A3.','.A3.','.A3.','.
     1A3.3X.A1.3X.I2)
  507 FORMAT(1H .T20.I3.5X.20A2.14X.A3.' '.A3.' '.A3.' '.A3.' '.A3.' '.
     1A3.3X.A1.3X.I2)
  511 FORMAT(1H1.T52.'MAJOR APPLIANCE FINISHING'.5X.I1//)
  512 FORMAT(1H1.T52.'SMALL APPLIANCE FINISHING'.5X.I1//)
  513 FORMAT(1H1.T54.'FARM MACHINERY FINISHING'.5X.I1//)
  514 FORMAT(1H1.T49.'INDUSTRIAL MACHINERY FINISHING'.5X.I1//)
  515 FORMAT(1H1.T49.'COMMERCIAL MACHINERY FINISHING'.5X.I1//)
  516 FORMAT(1H1.T52.'WOOD FURNITURE FINISHING'.5X.I1//)
  517 FORMAT(1H1.T49.'SHEET. STRIP. AND COIL COATING'.5X.I1//)
  518 FORMAT(1H1.T52.'METAL FURNITURE FINISHING'.5X.I1//)
  519 FORMAT(1H1.T50.'PAPER AND PAPERBOARD COATING'.5X.I1//)
  520 FORMAT(1H1.T56.'FABRIC TREATMENT'.5X.I1//)
  521 FORMAT(1H1.T40.'EVAPORATION FROM SURFACE COATINGS (ALL CATEGORIES)
     1'.5X.I1//)
  522 FORMAT(1H .T20.'RANK'.4X.'SOURCE TYPE'.T90.'IMPACT FACTOR',T107.'C
     1L')
  523 FORMAT(1H .T20.'----'.4X.'-----------'.T90.'-------------',T107.'-
     1-')
  524 FORMAT(1H .T20.'RANK'.4X.'SOURCE TYPE'.T90.'EMISSION RATE'.T107.'C
     1L')
  525 FORMAT(1H .T20.'RANK'.4X.'SOURCE TYPE'.T90.'EMISSION RATE'.T107.'C
     1L'.T112.'CAT')
  526 FORMAT(1H .T20.'RANK'.4X.'SOURCE TYPE'.T90.'IMPACT FACTOR'.T107.'C
     1L'.T112.'CAT')
  527 FORMAT(1H .T20.'----'.4X.'-----------'.T90.'-------------'.T107.'-
     1-'.T112.'---')
  531 FORMAT(1H0/T28.'TOTAL'.T82.A3.' '.A3.' '.A3.' '.A3.' '.A3.' '.A3.3
     1X.A1)
  532 FORMAT(1H0/T28.'TOTAL'.T82.A3.' '.A3.' '.A3.' '.A3.' '.A3.','.A3.
     13X.A1)
  533 FORMAT(1H0/T28.'TOTAL'.T82.A3.' '.A3.' '.A3.' '.A3.','.A3.','.A3.
     13X.A1)
  534 FORMAT(1H0/T28.'TOTAL'.T82.A3.' '.A3.' '.A3.','.A3.','.A3.','.
     1A3.3X.A1)
  535 FORMAT(1H0/T28.'TOTAL'.T82.A3.' '.A3.','.A3.','.A3.','.A3.','.A3.
     13X.A1)
  536 FORMAT(1H0/T28.'TOTAL'.T78.A3.','.A3.','.A3.','.A3.','.A3.','.A3.
     13X.A1)
      END
      SUBROUTINE ROUND(NFIG,XNUM,NDIG,NUM)
C     THIS SUBROUTINE DETERMINES THE NUMBER OF DIGITS AND ROUNDS THE
C     IMPACT FACTOR TO ONE SIGNIFICANT DIGIT.
      ANUM=XNUM
      IF(ANUM.LT.1.0) GO TO 5
      DO 1 IL=1,18
      ANUM=ANUM/10.0
      IF (ANUM.LT.1.00) GO TO 2
    1 CONTINUE
    2 NDIGIT=IL
      ANUM=ANUM*10.0**NFIG
      AFRAC=AMOD(ANUM,1.0)
      INTA=IFIX(ANUM)
      IF(AFRAC.GE.0.50) GO TO 3
      NUM=INTA
      NDIG=NDIGIT
      RETURN
    3 IF(INTA.EQ.9) GO TO 4
      NUM=INTA+1
      NDIG=NDIGIT
      RETURN
    4 NUM=1
      NDIG=NDIGIT+1
      RETURN
    5 NUM=1
      NDIG=1
      RETURN
      END
```

```
      SUBROUTINE REFMT1(I,IC,A,ISTMT)
      DIMENSION A1(9),A2(9),A3(9),A(6),IDESC(30),ISCL(4)
      DATA A1/'100','200','300','400','500','600','700','800','900'/
      DATA A3/' 10',' 20',' 30',' 40',' 50',' 60',' 70',' 80',' 90'/
      DATA A2/'  1','  2','  3','  4','  5','  6','  7','  8','  9'/
      DATA ADUM/'   '/,AZERO/'000'/
      IR=MOD(I,3)
      IF(IR.EQ.0) ANUM=A1(IC)
      IF(IR.EQ.1) ANUM=A2(IC)
      IF(IR.EQ.2) ANUM=A3(IC)
      DO 8 J=1,6
    8 A(J)=ADUM
      IF(I.LE.3) GO TO 10
      IF(I.GT.3.AND.I.LE.6) GO TO 20
      IF(I.GT.6.AND.I.LE.9) GO TO 30
      IF(I.GT.9.AND.I.LE.12) GO TO 40
      IF(I.GT.12.AND.I.LE.15) GO TO 50
      IF(I.GT.15.AND.I.LE.18) GO TO 60
   10 A(6)=ANUM
      ISTMT=1
      RETURN
   20 A(5)=ANUM
      A(6)=AZERO
      ISTMT=2
      RETURN
   30 A(4)=ANUM
      A(5)=AZERO
      A(6)=AZERO
      ISTMT=3
      RETURN
   40 A(3)=ANUM
      A(4)=AZERO
      A(5)=AZERO
      A(6)=AZERO
      ISTMT=4
      RETURN
   50 A(2)=ANUM
      A(3)=AZERO
      A(4)=AZERO
      A(5)=AZERO
      A(6)=AZERO
      ISTMT=5
      RETURN
   60 A(1)=ANUM
      A(2)=AZERO
      A(3)=AZERO
      A(4)=AZERO
      A(5)=AZERO
      A(6)=AZERO
      ISTMT=6
      RETURN
      END
```

APPENDIX E

SAMPLE PRIORITIZATION CALCULATION

Sample Impact Factor Calculation

1. Product-Type: Beverage Cans

2. Data

A. Stored Constants

π = 3.14159

$\bar{\mu}$ = wind speed = 4.47 m/sec (10 mph)

e = base e = 2.72

TLV's

Component	TLV, g/m^3
Solvent Emissions	
Aliphatic Hydrocarbons	2.800
Aromatic Hydrocarbons	0.375
Saturated Alcohols	0.500
Ketones	0.590
Saturated Esters	0.710
Saturated Ethers	0.120
Resin Emissions	
Alkyd	0.012
Vinyl	0.0026
Acrylic	0.410
Epoxy	0.019
Urethane	0.00014
Cellulosic	0.590
Amino	0.006
Rosin Ester	0.001
Styrene	0.420
Phenolic	0.012
Hydrocarbon	0.560

B. State Data

State code	State	Population (1970 census)	Population fraction	Area, km^2	Area fraction	No. of counties
1	Alabama	3,444,165	0.0170100	133,667	0.01428	67
2	Alaska	302,173	0.0014924	1,518,807	0.16221	29
3	Arizona	1,772,482	0.0087539	295,024	0.03151	14
4	Arkansas	1,923,295	0.0094987	137,539	0.01469	75
5	California	19,953,134	0.0985443	411,015	0.04390	58
6	Colorado	2,207,259	0.0109012	270,000	0.02884	63
7	Connecticut	3,032,217	0.0149755	12,973	0.00139	8
8	Delaware	548,104	0.0027070	5,328	0.00057	3
9	Florida	6,789,443	0.0335316	151,670	0.01620	67
10	Georgia	4,589,575	0.0226669	152,489	0.01629	159
11	Hawaii	769,913	0.0038024	16,706	0.00178	5
12	Idaho	713,008	0.0035214	216,413	0.02311	44
13	Illinois	11,113,976	0.0548896	146,076	0.01560	102
14	Indiana	5,193,669	0.0256504	93,994	0.01004	92
15	Iowa	2,825,041	0.0139523	145,791	0.01557	99
16	Kansas	2,249,071	0.0111077	213,064	0.02276	105
17	Kentucky	3,219,311	0.0158995	104,623	0.01117	120
18	Louisiana	3,643,180	0.0179929	125,675	0.01342	64
19	Maine	993,663	0.0049075	86,027	0.00919	16
20	Maryland	3,922,399	0.0193719	27,394	0.00293	23
21	Massachusetts	5,689,170	0.0280976	21,386	0.00228	14
22	Michigan	8,875,083	0.0438322	150,779	0.01610	83
23	Minnesota	3,805,069	0.0187924	217,736	0.02325	87
24	Mississippi	2,216,912	0.0109489	123,584	0.01320	82
25	Missouri	4,677,399	0.0231007	180,487	0.01928	114
26	Montana	694,409	0.0034295	381,087	0.04070	56
27	Nebraska	1,483,791	0.0073281	200,018	0.02136	93
28	Nevada	488,738	0.0024138	286,299	0.03058	16
29	New Hampshire	737,681	0.0036433	24,097	0.00257	10

B. State Data (Cont.)

State code	State	Population (1970 census)	Population fraction	Area km^2	Area fraction	No. of counties
30	New Jersey	7,168,164	0.0354020	20,295	0.00217	21
31	New Mexico	1,016,000	0.0050178	315,115	0.03366	32
32	New York	18,241,266	0.0900897	128,402	0.01371	62
33	North Carolina	5,082,059	0.0250992	136,198	0.01455	100
34	North Dakota	617,761	0.0030510	183,022	0.01955	53
35	Ohio	10,652,017	0.0526081	106,765	0.01140	88
36	Oklahoma	2,559,253	0.0126396	181,090	0.01934	77
37	Oregon	2,091,385	0.0103289	251,181	0.02683	36
38	Pennsylvania	11,793,909	0.0582476	117,412	0.01254	67
39	Rhode Island	949,723	0.0046905	3,144	0.00034	5
40	South Carolina	2,590,516	0.0127940	80,432	0.00859	46
41	South Dakota	666,257	0.0032905	199,552	0.02131	67
42	Tennessee	3,924,164	0.0193806	109,412	0.01169	95
43	Texas	11,196,730	0.0552983	692,405	0.07395	254
44	Utah	1,059,273	0.0052315	219,932	0.02349	29
45	Vermont	444,732	0.0021964	24,887	0.00266	14
46	Virginia	4,648,494	0.0229579	105,716	0.01129	96
47	Washington	3,409,169	0.0168372	176,617	0.01886	39
48	West Virginia	1,744,237	0.0086144	62,629	0.00669	55
49	Wisconsin	4,417,933	0.0218192	145,439	0.01553	72
50	Wyoming	332,416	0.0016417	253,597	0.02709	23
	Totals	202,478,816	1.0000	9,362,992	1.0000	

C. Input Data

Total Capacity (TCAP) = 3.74×10^{10} cans/year

Frequency of Operation (f) = 1.0

Number of Materials Emitted (N) = 11

Height of Emissions (H) = 15.2 m (50 ft)

State Information

State Code	Number of Plants
13	1
32	1
35	1
38	3

Emission Factors

Aliphatic Hydrocarbons (EF_1) = 0.956 g/can
Aromatic Hydrocarbons (EF_2) = 0.785 g/can
Saturated Alcohols (EF_3) = 0.166 g/can
Ketones (EF_4) = 2.657 g/can
Saturated Esters (EF_5) = 0.269 g/can
Saturated Ethers (EF_6) = 0.002 g/can
Alkyd Resin (EF_7) = 0.073 g/can
Vinyl Resin (EF_8) = 0.055 g/can
Acrylic Resin (EF_9) = 0.007 g/can
Urethane Resin (EF_{10}) = 0.005 g/can
Amino Resin (EF_{11}) = 0.042 g/can

3. Calculation

There are 11 materials emitted in each of 4 states. For computational purposes, this corresponds to 44 separate, identical calculations. Therefore, only three materials in one state will be shown; the remaining steps follow by induction.

State 13 (Illinois)

$$\text{Capacity } (CAP_{13}) = \frac{1}{6}\ TCAP$$

$$= 6.23 \times 10^{9} \text{ cans/year}$$

Population Density = 76 persons/km^2

Procedure: Illinois

For aliphatic hydrocarbons,

$$Q_1 = \frac{1}{f}\ (YPS)(CAP_{13})(EF_1)$$

$$Q_1 = \frac{1.0}{1.0}\ (3.17 \times 10^{-8} \text{ yr/sec})(6.23 \times 10^{9} \text{ cans/yr})(0.956 \text{ g/can})$$

$$Q_1 = 188.8 \text{ g/sec}$$

$$\overline{\chi}_{1\max} = \frac{2Q}{\pi H^2 e\bar{u}}$$

$$\overline{\chi}_{1\max} = \frac{(2)(188.8)}{(3.14159)(231.04)(2.72)(4.47)}$$

$$\overline{\chi}_{1\max} = 0.0428 \text{ g/m}^3$$

$$F_1 = TLV_1\ \frac{40}{16800}$$

$$F_1 = 2.800\ \frac{40}{16800}$$

$$F_1 = 6.67 \times 10^{-3} \text{ g/m}^3$$

Define:

$$A_1 = \frac{\overline{\chi}_{1\max}}{F_1}^{2}\ \frac{\chi_{11}}{S_1}^{2}$$

$$A_1 = \frac{0.0428}{0.00667}^{2}\ \frac{1}{1}^{2}$$

$$A_1 = 41.2$$

For aromatic hydrocarbons,

$$Q_2 = \frac{1.0}{1.0} (3.17 \times 10^{-8})(6.23 \times 10^{9})(0.785)$$

$$Q_2 = 155 \text{ g/sec}$$

$$\bar{\chi}_{2\max} = \frac{(2)(155)}{(3.14159)(231.04)(2.72)(4.47)}$$

$$\bar{\chi}_{2\max} = 0.0351 \text{ g/m}^3$$

$$F_2 = 0.375 \left(\frac{40}{16800}\right)$$

$$F_2 = 8.93 \times 10^{-4} \text{ g/m}^3$$

$$A_2 = \left(\frac{0.0351}{8.93 \times 10^{-4}}\right)^2 \left(\frac{1}{1}\right)^2$$

$$A_2 = 1545$$

For saturated alcohols,

$$Q_3 = \frac{1}{1.0} (3.17 \times 10^{-8})(6.23 \times 10^{9})(0.166)$$

$$Q_3 = 32.8 \text{ g/sec}$$

$$\bar{\chi}_{3\max} = \frac{2(32.8)}{(3.14159)(231.04)(2.72)(4.47)}$$

$$\bar{\chi}_{3\max} = 7.43 \times 10^{-3} \text{ g/m}^3$$

$$F_3 = 0.500 \left(\frac{40}{16800}\right)$$

$$F_3 = 1.19 \times 10^{-3} \text{ g/m}^3$$

$$A_3 = \left(\frac{7.43 \times 10^{-3}}{1.19 \times 10^{-3}}\right)^2 \left(\frac{1}{1}\right)^2$$

$$A_3 = 39.0$$

then:

$$I_{13} = P_{13}\ (A_1 + A_2 + A_3 + \ldots + A_{11})^{1/2}$$

$$I_{13} = 76\ (41.2 + 545 + 39.0 + \ldots + \quad)^{1/2}$$

$$I_{13} = 76\ (1.96 \times 10^5)^{1/2}$$

$$I_{13} = 3.46 \times 10^4$$

and so on for the remaining states:

$$I_x = I_{13} + I_{32} + I_{35} + I_{38}$$

$I_x = 1 \times 10^6$ to one significant digit.

SECTION IX

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